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THE COST OF SUBWAYS for pipes and wires alongside a portion of the New York Rapid Transit route has been roughly estimated by Mr. Wm. Barclay Parsons, M. Am. Soc. C. E., Chief Engineer, as $850,000. Subways would be practicable only from Worth St. to 33d St., but for that distance they might be made available for all existing subsurface structures, and for the future needs of many years. The Rapid Transit Commission, on March 16, instructed Mr. Parsons

to report at the next meeting relative to the necessity under now existing circumstances of constructing pipe galleries along the line of the subway in the portion thereof for which such galleries have been provided in the general plans, and as to the estimated cost of such work if done as extra work under the provisions of the contract of Feb. 21, 1900, with John B. McDonald.

THE $12,000,000 WATER IMPROVEMENT LOAN BILL has passed both branches of the city council of Philadelphia, and been approved by the Mayor. This makes $15,700,000 available for water purification, new pumping engines, mains and reservoirs.

MUNICIPAL OWNERSHIP OF THE OMAHA WATER-Works was carried by a large majority at a recent popular election. Bonds were voted, as we understand it, to buy the existing works.

A CHICAGO MADE-LAND DECISION, of wide application, was handed down in the U. S. Supreme Court, last week. The case was that of the City of Chicago vs. the Illinois Central R. R. Co., and touched the right of the company to build a roundhouse on about four acres of land reclaimed from Lake Michigan. The decision affects other land along the lake front claimed by the railway company, and valued at over $10,000,000, and establishes a precedent governing land made by property owners in the northern part of the city. The railway company claims the land under its charter from the State, which gives it the right to all such lands, waters, materials and privileges belonging to the State, as may be necessary, including land necessary for engine houses. The Supreme Court now declares that the State of Illinois has no right to grant submerged land within the boundaries of the city; and it only holds control of them in trust for the people, subject in this case to the control of the City Council. Some two years ago a compromise with the city was entered into, whereby the railway company agreed to lower its tracks, build retaining walls and pay the cost of filling the land between the tracks and the inner breakwater; the land so made was to be turned into a public park, and this work is now going on.

THE MOST SERIOUS RAILWAY ACCIDENT of the week was a rear end collision on the Baltimore & Ohio R. R., near Lemont, Pa., on March 14. A local freight train ran into the rear end of a shifting train, wrecking its engine and twelve cars and killing the engine driver.

A STAND-PIPE FELL AT ELGIN, ILL., about 7:15 a. m., March 14. Fortunately no one was injured, and the water ran down a hill through unoccupied property to the Fox River, with comparatively little damage. It is thought that the failure was due to ice, pieces of which from 20 to 26 ins. in thickness, were found scattered about after the failure. The stand-pipe was 30 × 95 ft., on a masonry substructure 20 ft. high. It was erected some ten or twelve years ago. We are indebted to Mr. Henry Dakin for the above information. In an early issue we expect to publish a full report on the accident.

THE PASSAIC RIVER POLLUTION SUIT, brought by riparian owners, to prevent the discharge of sewage into the river by the city of Paterson, has been decided in favor of the city, by the Court of Errors and Appeals, although the city is still liable for suits for damages on account of polluting the river. This decision reverses the one by Chancellor McGill, reviewed in our issue of March 9, 1899. It is based largely on the fact that the city had legislative authority to discharge its sewage into the river, and that the injury to the city by restraining it from using the river for sewage disposal purposes would be greater than that to the riparian proprietors through such use, the latter having an inviolable right to recover damages on proof.

THE BARREN ISLAND GARBAGE REDUCTION Works must be closed within 22 months, if a bill just passed by the New York legislature receives the approval of Mayor Van Wyck and Governor Roosevelt. It is supposed that the latter will approve the bill without question, and that if the Mayor vetoes it the legislature is likely to override the veto. The bill in question amends the Charter of Greater New York so as to prohibit the "rendering or treating with steam or boiling garbage, swill or offal," within the limits of the Borough of Brooklyn, which includes Barren Island. The act is to take effect immediately unless the board of health, upon application, extends the date for a period not exceeding 22 months. This provision is an amendment to the original bill, and, if the extension is made, postpones the effect of the act until after the expiration of the present contracts for garbage disposal by rendering. The Barren Island works were described at length in our issue of Feb. 1, 1900.

A LARGE PLANT OF ROTARY PUMPS is being erected at Raywood, Liberty Co., Texas., to supply water for the irrigation of rice plantations. There are six pumps, each of 50,000 gallons per minute capacity, and they are located in three pumping stations. At the first, a pair of pumps take water from the Trinity River and elevates it 15 ft. to a low level canal 3½ miles in length. At the second pumping station, water from the canal is raised 24 ft. higher to a second canal some four miles in length. The water is finally raised by a third lift of 30 ft. to the summit canal, seven miles in length, distributing water over 15,000 acres of rice fields. The pumps are in each case coupled direct to Corliss condensing engines, and the steam plants at each station have been carefully designed to secure economy and reliability in service. It is believed that this is the largest installation of rotary pumps ever made. The work is being done for the Raywood Rice Canal & Milling Co., by the P. H. & F. M. Roots Co., of Connersville, Ind.

IRRIGATION WORKS IN THE TRANS-CASPIAN possessions of Russia are to be undertaken on a large scale by an Anglo-American syndicate, says the Turkestan "Gazette." This journal reports that an agent is now at Tashkend preparing for work in that section, representing a capital of $2,000,000. It also says that American capital has been enlisted to undertake the reclamation and cultivation of that broad region known as the Hunger Steppe. It proposes a vast system of canals taking water from the River Syr Daria, and the estimated cost of the work is $77,250,000, to be guaranteed by a freehold lease of the whole of this region for 99 years.

THE GRAND CANAL, of the drainage system of the City of Mexico, was officially opened, on March 17, by President Diaz and his Cabinet.

THE EXPORTS AND IMPORTS for February, 1900, says the U. S. Bureau of Statistics, form the most remarkable record for this month in the history of our foreign commerce. The exports during that month averaged $5,000,000 for every business day, or an aggregate of $119,765,762; this exceeds by 25% the export record for any other February. The total imports amounted to $68,774,150, which were slightly larger than the imports for any preceding February, except that of 1893. The total exports for the eight months ending with February, 1900, amount to $919,873,086; the total imports for the same period are $555,069,817.

NORWEGIAN HOUSE-LINING MATERIALS are described by U. S. Consul V. E. Nelson, of Bergen. One of these is a so-called Savareid building pasteboard; it is made of specially prepared pasteboard, with layers of asphaltum between, and then compressed into a solid plate. It is used for covering walls and ceilings, and is damp-proof, a non-conductor of heat, deadens sound and will keep away all manner of vermin. It is very pliable and bends around angles without breaking; it is also odorless and will not rot. The other is called "campo-board," and is a board made in five layers, as follows: The central layer is made of pieces of wood fitted close together and lying in different directions; the adjoining layers are made of a very strong cement, penetrating the central boards and binding them firmly together; the two outer layers are made of sheets of very heavily compressed, waterproof paper. The campo-board is made in sheets 4 ft. wide by 8 to 18 ft. long. It is used for house-lining, for ship-lining, for trunks, tables, desks, bottoms of drawers, signs, etc. It can be polished or painted.

THE RAILWAYS OF PRUSSIA AND HESSE are owned by the government and operated by a joint management; except for 1,584 miles of private lines. A recent report of the Prussian Minister of Public Works gives the following statistics of these roads: Total length, 18,494 miles, of which 12,410 miles are main lines and the remainder local lines; 11,089 miles are single track and 7,329 miles double track. The invested capital is $1,802,129,336, or $97,444 per mile. The equipment includes 12,070 locomotives, 21,887 passenger cars, 5,713 baggage cars, and 267,397 freight cars. The purchase value of this equipment is put down at $357,000,000, or 19.62% of the total invested capital. In 1898-99, the receipts from passengers was $78,570,000, or 15 cts. for every person transported, or 1.025 cts. per mile. Of freight, 192,780,000 tons were transported, to which must be added 13,830,000 tons carried free or charge; the receipts from freight amounted to $199,150,000, or $1.33 per ton on an average. The net profits are equal to 7.07% on the total capital invested.

THE NEW SHOPS of the Chicago Great Western Ry., at Oelwein, Minn., consist mainly of two long buildings on opposite sides of the pit of a transfer table having a travel of 750 ft. The main building contains the store house, machine and erecting shop, boiler shop and coach shop. The opposite building contains the freight car shop, blacksmith shop and paint shop. There are also separate buildings for the wood shop, wheel shop and power house. The tools are driven by belts from shafts operated by electric motors, and there are also numerous air hoists, as well as portable pneumatic tools. The current for light and power is all generated in the power house, where the air compressor is also situated. There are two Ideal engines, three 100-K-W. dynamos, three Stirling water-tube boilers and a Norwalk air compressor. Some of the buildings are heated by exhaust steam, and others by hot air, the Sturtevant fans for the latter system being driven by electric motors. Most of the buildings are of brick, with steel roof trusses and tile roofs. The general plan was designed by Mr. Tracy Lyon, who was Master Mechanic, but has since been made General Superintendent. The architect was Mr. W. A. Reed, of St. Paul, and the power plant was furnished by the Arnold Electric Power Station Co., of Chicago.

THE STEAMER "SAVOIE," of the Compagnie Generale Transatlantique, was launched, on March 13, at Saint-Nazzaire, France. The "Savoie" is said to be the largest steamship ever constructed in a French shipyard. She is 533 ft. long and 60 ft. beam. Her tonnage is 10,500, and her engines are 12,000 HP., and are calculated to give her a trial speed of 22 knots. She will run on the line between Havre and New York.

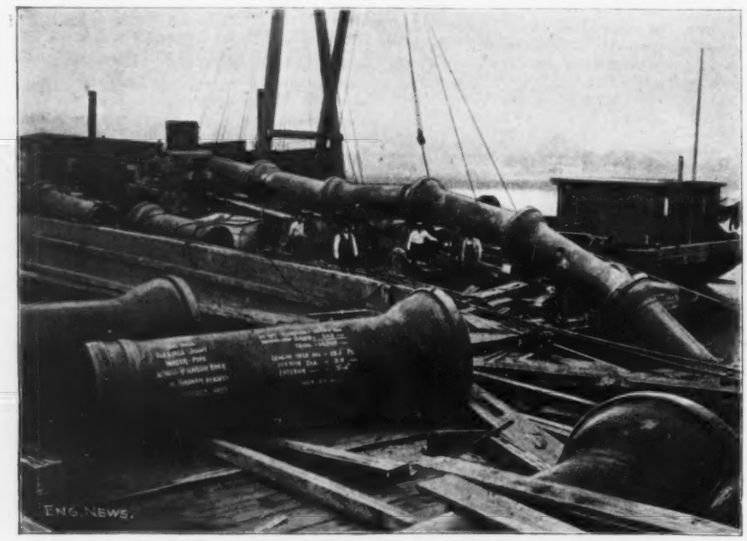
THE NEW WARSHIPS recommended by the House Committee on Naval Affairs rate as follows: Two seagoing coast line battleships, of about 13,500 tons each, to cost about $3,000,000 each; three armored cruisers, of the highest practical speed and most powerful armor and armament, to cost about $4,000,000 each; and three protected cruisers, to cost about $1,141,000 each. The committee also authorizes the Secretary of the Navy to contract for armor at a price not exceeding $545 per ton, for about 7,400 tons required for the "Maine," "Missouri" and "Ohio," battleships now under construction. Sheathing is left discretionary with the Secretary.

THE NEW DRIGGS SEMI-AUTOMATIC 6-PDR., for the U. S. Navy, is shown to be a remarkable gun by late tests at Indian Head. Its great advantage is that it may be fired as deliberately as may be, or at the extreme rate of 75 rounds per minute; while the previous best speed record for a similar gun was 42 rounds. In this gun the bore and chamber and loading and sighting are the same as in the original Driggs-Schroeder, with the same accuracy and range. This accuracy was shown in the Sandy Hook trial of 1894, when at a range of one mile 10 shots were landed in a 3-ft. circle consecutively, with a mean deviation from the center of 1 ft. 1 in. Ten shots were also put into this target in 1 m. 36½ s., and all inside a circle 12 ft. in diameter. The 6-lb. shell explodes on impact, and is united in one cartridge with the firing charge. This cartridge is inserted in the chamber by hand; but as soon as it is in place, the gun closes, is fired, the breech opens and ejects the empty case, leaving the gun ready for another cartridge. It works automatically, and the loading and firing are continuous as long as the gunner holds the trigger back; but when this trigger is released and thrown back, he can fire at will, as with an ordinary hand-worked gun. The mechanism is very simple, and the guns are being rapidly turned out for the armament of the gunboat type of warship.

LAYING A 36-IN. WATER MAIN UNDER THE HARLEM RIVER, NEW YORK.

The city of New York has recently completed the laying of a 36-in. water main across the Harlem River, between Fordham Heights Landing and 209th St., Manhattan. It is intended to better supply with water that long strip of territory lying between the Hudson and the Harlem River, and the line is chiefly remarkable for the excessive weight of the jointed pipe used in crossing the river.

At the point crossed the Harlem River is 1,200 ft. wide; and, to meet future demands from commerce in this improved waterway, it was necessary to dredge a trench across the river to a depth of 30 ft. below mean low water. As there is a strong tidal current in the Harlem, since its recent improvement by the government, this trench gave considerable trouble, and constant dredging was required to remove the silt brought into it by the action of the current.



LAYING A 36-IN. FLEXIBLE JOINT WATER MAIN ACROSS THE HARLEM RIVER, NEW YORK CITY.
E. R. Lowe, Contractor.

The flexible-joint pipe used was 36 ins. inside diameter, and was made to lay in 12-ft. lengths, with a bell and spigot joint at the two ends. The joint itself is a modification of the Ward flexible joint, as devised by Mr. Duane. The bell was 5 ft. in outside diameter at the extreme end, and was there reinforced by shrinking upon it an iron band, 6 ins. wide and 2¼ ins. thick; the bell was about 30 ins. long. The spigot-end was provided with two cast bands, 5 ins. wide and rounded to fit the spherical interior of the bell; the dovetailed space between these bands was 6 ins. wide by ¾-in. deep, and into this space was poured the lead which completed the flexible joint. Each of these joints required 1,100 lbs. of lead. Each pipe-length as delivered was 13 ft. 1 in. long, 36 ins. interior diameter and 40 ins. exterior diameter in the body of the pipe. The wrought-iron band referred to weighed 663 lbs., and the cast-iron pipe weighed 13,725 lbs., or 14,388 lbs. for the pipe-length complete.

The work of laying the 1,200 ft. of jointed pipe was commenced in June, 1899, and completed on Dec. 6, 1899, by the contractor for this portion of the work, Mr. E. R. Lowe, of No. 2 Coenties Slip, New York. The method adopted by Mr. Lowe for laying the flexible pipe was about as follows: A strong float, 97 ft. long and 35 ft. wide, was provided with a steam derrick for handling the pipe-sections; blocking for holding about five pipe-lengths at one time on the boat; a launching way at one end of the float, etc. After the pipe had left the Fordham bank of the river, strong steel cables were securely attached to the pipe itself, and by means of these cables the float was handled and the pipe was launched, section by section. Four precautionary anchors were used to guard against damage to the float from passing vessels. But as each joint was completed, the steel cables were cautiously slackened, and the weight of the pipe practically pushed the float towards the far shore as one pipe-length after another slipped into the water. The cables were then again made fast, and another pipe-length was lifted, put in place, and attached, by pouring its joint, to the four lengths still remaining on the float; a repetition of this process, as pipe after pipe was added, finally resulted in the successful completion of the line across the river. The work required extreme care and great experience and judgment in handling the cables; and Mr. Lowe himself lived upon the float, day and night, throughout the operation. As it was city work, the cost of the pipe and its laying could not be ascertained. It might be mentioned that as the laying progressed the cables referred to were shifted by divers, as the conditions demanded.

NEW OFFICE BUILDING OF THE WESTINGHOUSE ELECTRIC & MANUFACTURING CO.

A fireproof office building, 50×150 ft. in plan and seven stories high, has recently been completed by the Westinghouse Electric & Mfg. Co., especially to house the staff officials of the company and their assistants. This building is located adjacent to the company's works in East Pittsburg, Pa., and will be occupied entirely by its staff employees. In construction and equipment the building presents several interesting features, among which the following will be of particular interest to engineers.

The entire end of the building, 50 ft. wide, is occupied by fireproof vaults. At a distance of 24 ft. from the outer wall a fireproof brick wall is carried upwards from the foundation to the roof, forming fireproof vaults upon the several floors, each having an area of 1,200 sq. ft. Entrance to these six vaults is through two sets of double fireproof iron doors on each floor. The vaults are for the safe custody of the valuable plans and blue prints of electrical machinery, the general books and records of the company, and for the large collection of negatives, photographs and electrotypes.

The ventilation of the building was given careful attention. Upon the sixth floor under the roof is a large horizontal ventilating shaft running from end to end of the building, with flues connecting each room with the main shaft. An electric motor operates a Sturtevant fan in the center of the main shaft, which during the winter expels the vitiated air, driving it above the roof. Fresh air is admitted into the offices by a part of the heating system, passing through shafts in the wall behind radiators, which heat the air as it is admitted.

The building is lighted throughout by electricity, the current being obtained from the central power house of the company. The heating of the building is by direct radiation, using steam from two 50-HP. tubular boilers installed upon the ground floor. From the boiler the steam is conveyed to the top of the building by mains which extend horizontally above the sixth floor. When leaving the main the steam passes through a valve reducing the pressure from 15 lbs. to 1 lb., and is then carried by risers to the radiators on each floor. There are nearly 50 radiators on each floor, having 8,000 ft. of radiating surface. Thermostatic valves automatically govern the temperature. When a certain amount of steam is admitted, the heat expands the joints, closing the valves and cutting off the steam, and when the temperature falls, the valves reopen admitting a further supply of heat. A Warren-Webster vacuum pump removes the condensed water from the radiators and pipes, and an electrically-driven pump passes it to the boilers.

The two passenger elevators have a traveling distance of 73 ft. from the ground to the sixth floor, each one being rated to carry 1,500 lbs. 400 ft. a minute. They are operated upon the electro-hydraulic system, the mechanical plant being upon the ground floor. The hydraulic apparatus includes two large water tanks, one of them containing water under pressure. Two Westinghouse type "C" motors operate pumps which force the water from the low pressure to the high pressure tank. As soon as the pressure is reduced to 100 lbs., by using the elevators, a weight falls which automatically closes the switches, and the electric motors commence to drive the pumps until the pressure in the tank is raised to 140 lbs., when the switches open automatically and the motors stop. As the water leaves the high pressure tank it returns to the other one, and is thus used over and over again. To control the stoppage of the elevators when reaching the two extremes of its journey, there is a cut-off valve, so that should the operator inadvertently fail to move the lever, the car slows down and stops automatically. A safety clamp is also provided to stop the elevator in case of accident to the hoisting cables.

Among the recent improvements made in the company's plant is the system of pneumatic tubes whereby all the works, departments and all of the offices are connected through a central exchange station. The central station of this system is upon the second floor, and it contains twelve sending and receiving tubes, furnishing service to all floors of the office building and to the important points in the works. The tubes are of brass, 2½ ins. in diameter, the longest line being 3,500 ft. The circuit of this line can be made in from 40 to 45 secs., or at a speed of about a mile a minute. The system is operated by a positive exhauster of the Connersville type, which, exhausting the air from the tubes, allows an inrush of air from the atmosphere which forms the pressure that propels the carriers and their freight to their destination, where it is discharged through an air valve, which immediately closes, thus forming the circuit back to the starting point. The pressure, or vacuum maintained is about 24 oz., which is capable of handling a carrier and load equal to 8 lbs. at the speed mentioned above. All the mail and other matter is distributed by this system in a very much shorter time than it could be delivered by messengers.

FIREPROOF COTTON, LINEN AND WOOLEN goods form a new product in Germany, says U. S. Consul E. T. Liefeld, of Freiburg. The process is secret, but it is a chemical treatment of the materials, cheap and rapid, that adds very little to the weight and does not alter the color or the strength of the goods. Mr. Liefeld says that while a candle-flame held to goods thus treated would char the fiber where the flame was in direct contact, the fire did not spread. One of its disadvantages is that it cannot be used out of doors, as water will dissolve the chemicals; but any such materials can be washed and then quickly and cheaply reimpregnated. Steam and moisture do not affect its fireproof qualities, nor does the application of heat. The manufacturers claim that it is in no way poisonous. The cost of treatment is about 3 cts. per sq. yd., and less in large quantities. The increase in weight due to treatment is from 10 to 20 grammes per sq. meter. The process has been in use for some time in the manufacture of horse-blankets, tents, etc.

THE ACTION OF WATER ON ASPHALTS *

By George C. Whipple and Daniel D. Jackson.†

The rapidly increasing use of asphalt as a material for engineering construction demands a thorough scientific investigation of the properties of that substance as a matter of practical necessity. At one time nearly all of the asphalt used in this country was imported; now there are many American asphalts, besides numerous artificial products. These various kinds of asphalts differ in many of their characteristics, and one might think that it is comparatively easy to determine their relative suitability for various uses, but when it is remembered that they may be mixed with each other in almost any proportion, the complexity of the problem becomes apparent. The practical tests to be applied to asphalts are largely physical. It is useful to know their chemical composition, but it is more important to know their consistency, viscosity, elasticity, ductility, fracture, etc., and the relative importance of these tests varies with the nature of the work for which the asphalts are to be used.

In many places, if not in most places, where asphalt is used, its surface is subjected to the action of water. Street pavements are being continually washed by rains, and during the winter the surface of the asphalt may be for a long time in contact with snow and ice. The various forms of asphalt paints are intended primarily to protect metallic substances from weathering and from the corrosive action of water. The use of asphalt as a lining for reservoirs brings this subject into still greater prominence. Here the contact with water takes place under various conditions. Above the water line the asphalt surface may be alternately wet and dry; near the water line it is subjected to the erosive action of the waves and to the force of the ice in winter; while at the bottom of the reservoir there is the effect of pressure.

It is evident that one of the first requisites of an asphalt for reservoir lining is that it shall not be injuriously acted upon by water, either physically or chemically. If such an action does take place, the efficiency of the substance is impaired and the life of the structure reduced. Experience has shown that some asphalts are acted upon by water to a considerable extent, while others are apparently unaffected. The following investigation was undertaken to determine the relative action of water upon some of the most important asphalts on the market, with reference to their use for reservoir lining.

The refined asphalts used for the experiments were the following:

1. Trinidad Lake asphalt.
2. Bermudez asphalt.
3. Alcatraz asphalt, Grade D.
4. Alcatraz asphalt, Grade XX.
5. Alcatraz maltha, No. 1.
6. Alcatraz maltha, No. 2.
7. Cuban asphalt, No. 1.
8. Cuban asphalt, No. 2.
9. Assyrian asphalt, No. 2.
10. Assyrian asphalt, No. 3.
11. Assyrian asphalt, No. 4.
12. Assyrian asphalt, No. 5.
13. Assyrian asphalt, No. 6.
14. Assyrian asphalt, No. 7.
15. Asphaltina.
16. Asphaltina mixed with Cuban.
17. Petroleum residuum.

Samples Nos. 1 to 6 were personally collected at the yards of the respective companies, the samples being selected with great care from large masses. Samples 7 to 17 were not personally collected.

The experiments were conducted along three lines: First, that of placing samples of the asphalts in contact with water in glass jars and subsequently noting the change in the analysis of the water, thereby ascertaining the nature of the soluble constituents of the asphalts. Second, that of immersing samples of the asphalts in water under various conditions and noting their change in weight. Third, that of observing the action of water upon the asphalts by noting changes in their physical condition.

In order to study the soluble constituents, the asphalts were melted and poured into glass jars so as to form a layer at the bottom about 1 cm. thick, and having an average area of about 60 sq. cm.; 800 cu. cm. of water were then added, and the jars closed to prevent evaporation. Two jars were used for each sample, one being filled with distilled water and the other with surface* water from the eastern part of the Brooklyn watershed. In the case of the Trinidad and Bermudez asphalts a third jar was prepared and filled with water from some of the deep wells of the Brooklyn Water Supply. At the end of two months a portion of the water in each jar was removed and analyzed. After two years the remaining water was subjected to analysis. The sample of asphaltina was not received until December, 1898, and consequently the analysis represents but one year's action.

For the second series of experiments the asphalts were melted at as low a heat as possible and poured into watch-glasses, where they spread out into thin cakes with smooth surfaces. These cakes contained equal amounts of asphalt and presented surface areas that varied from 45 to 55 sq. cm. The watch-glasses, with their adhering cakes of asphalt, were dried in desiccators and weighed. They were then mounted on agate-ware plates, fastened with copper wire, and suspended in water. In order to determine the effect of different waters and of different conditions, such as pressure, temperature, light, current, etc., the Trinidad, Bermudez and Alcatraz D asphalts were suspended in Mt. Prospect Reservoir near the surface, where the pressure was small and the temperature changes considerable; in Mt. Prospect stand-pipe, at a depth of 50 ft., where they were in darkness, where the pressure was great and also variable, and where the changes of temperature were small; and in the conduit at Freeport, where they were subjected to the action of water different in quality from the two preceding, where the pressure was small, but the current strong. The remaining asphalts were exposed in but one place. From time to time the samples were withdrawn from the water, and cleansed by washing with distilled water and rubbing with a fine camel's hair brush. They were then dried in desiccators, weighed, and replaced in the water.

The action of the water upon the various asphalts was observed in both sets of experiments by inspection and by microscopical examination of the surface, and in the first set, by measurement of the depth to which the action of the water extended during two years' exposure. The results of these observations were as follows:

No. 1. Trinidad Lake Asphalt.—The action of the water upon this asphalt was strong. Two weeks' exposure caused a roughening of the surface and a change in color from black to brown. With longer exposure the brown color was more conspicuous, and the surface became granular. Finally, the upper portion of the asphalt changed to a soft, punky material, covered with cracks and pits. In the jars a thin layer of loose material had become more or less detached from the surface. The samples that stood in the jars for two years were examined in cross-secton under the microscope and the depth of the action determined by careful measurement. In the distilled water the soft, brown surface layer was 1.32 mm. thick; in the surface water it was 1.12 mm., and in the well water it was 1.10 mm.

No. 2. Bermudez Asphalt.—The action of the water upon this asphalt was noticeable and similar in character to that just described, but it proceeded much more slowly and was far less in amount. For a long time the surface remained black; later it became brownish. At first there was a slight cracking of the surface, but afterward the surface became wrinkled. In the jars the depth of action was .03 mm. in distilled water; .02 mm. in the surface water, and .01 mm. in the well water.

No. 3. Alcatraz Asphalt, Grade D.—There was a slight, but measurable, action upon this asphalt. The color changed from black to brown, but the surface remained quite smooth. The depth of action in the jars was .005 mm.

No. 4. Alcatraz Asphalt, Grade XX.—This asphalt showed greater action than the preceding, and almost as much as the Bermudez. At the end of two years the surface of the asphalt in the jar was brown and wrinkled. The depth of action was .015 mm. in distilled water, and .010 mm. in the surface water and well water.

No. 5. Alcatraz Maltha, No. 1.—The action of the water upon this maltha was confined to a thin film at the surface. The color changed from black to brown, but on drying the brown color almost disappeared.

No. 6. Alcatraz Maltha, No. 2.—The action was not quite as strong as in the case of Maltha No. 1.

No. 7. Cuban Asphalt, No. 1.—This asphalt had a hard, shining surface and was exceedingly brittle. There was no apparent action.

No. 8. Cuban Asphalt, No. 2.—This asphalt is also very brittle. There was a very slight action at the surface with a change in color from black to brown. The depth of the action was too small to be measured.

No. 9. Assyrian Asphalt, No. 2.—There was no apparent action.

No. 10. Assyrian Asphalt, No. 3.—There was no apparent action.

No. 11. Assyrian Asphalt No. 4.—There was almost no action, though in one case the surface was very slightly browned.

No. 12. Assyrian Asphalt, No. 5.—This asphalt was considerably acted upon. The color was decidedly brown, and the surface spongy. The depth of action was .02 mm. in distilled water, and .01 in the surface water. This product is not intended to be used in contact with water.

No. 13. Assyrian Asphalt, No. 6.—There was no apparent action.

No. 14. Assyrian Asphalt, No. 7.—There was no apparent action.

No. 15. Asphaltina.—There was a very slight action, but it was too small to be measured.

No. 16. Asphaltina Mixed with Cuban.—There was no apparent action.

No. 17. Petroleum Residuum.—There was no apparent action.

Table I. shows the depth of the action of distilled water, surface water, and well water on the various asphalts. It should be remembered that these figures have only a relative value, as the conditions of the experiments were different from those of actual practice.

Table II. shows the loss from the asphalts after two months' exposure in the jars, obtained by analysis of the supernatant water, as above described. The results are expressed in "grams per square meter of exposed surface." The figures in the first horizontal line represent the total solid matter taken up by the water; those in the second line, the amount of organic matter volatile at a temperature just sufficient to redden platinum; those in the third line, the fixed solids.

It will be seen that to a certain extent the amount of soluble matter corresponds with the intensity of the action of the water upon the asphalts. For example, in almost every case the action was greatest in the jars that contained distilled water, and in those jars, also, the largest amounts of soluble matter were taken up by the

*A paper read before the Brooklyn Engineers' Club, March 8, 1900.

†Mt. Prospect Laboratory, Brooklyn, N. Y.

TABLE I.—Showing the Amount of Action of Distilled Water, Surface Water, and Ground Water upon Various Asphalts During Two Years' Exposed in Glass Jars.

Asphalt.	Depth, in mm., to which the action of the water was observed— Distilled water.	Surface water.	Ground water.
Trinidad Lake asphalt	1.320	1.120	1.100
Bermudez asphalt	.030	.020	.010
Alcatraz asphalt, Grade D	.005	.005	trace.
" asphalt, Grade XX	.015	.010	....
" maltha, No. 1	trace.	trace.	....
" maltha, No. 2	trace.	trace.	....
Cuban, No. 1	.000	.000	....
Cuban, No. 2	trace.	trace.	....
Assyrian, No. 2	.000	.000	....
" No. 3	.000	.000	....
" No. 4	.000	trace.	....
" No. 5	.020	.010	....
" No. 6	.000	.000	....
" No. 7	.000	.000	....
Asphaltina	trace.	....	....
Mixed with Cuban	.000	....	....
Petroleum residuum	.000	.000	....

*This "surface water" is really a mixture of water from ponds and driven wells.

TABLE II.—Showing the Loss from Various Asphalts Exposed for Two Months to the Action of Waters of Different Quality in Glass Jars.

(In grams per square meter of exposed surface.)

Asphalts.		Total solids.	Loss on ignition.	Fixed solids.
Trinidad Lake	Distilled water	2.53	0.72	1.81
	Surface "	1.44	0.24	1.20
	Ground "	1.87	0.36	1.51
Bermudez	Distilled "	1.23	0.72	0.51
	Surface "	1.32	0.36	0.96
	Ground "	0.46	0.18	0.28
Alcatraz D	Distilled "	0.84	0.30	0.54
	Surface "	0.96	0.32	0.64
XX	Distilled "	1.37	0.40	0.97
	Surface "	0.51	0.40	0.11
Maltha No. 1	Distilled "	1.29	0.72	0.57
	Surface "	1.20	0.54	0.66
Maltha No. 2	Distilled "	1.50	0.60	0.90
	Surface "	1.08	0.54	0.54
Cuban No. 1	Distilled "	1.31	0.57	0.74
	Surface "	0.34	0.23	0.11
Cuban No. 2	Distilled "	0.86	0.00	0.86
	Surface "	0.51	0.23	0.28
Assyrian No. 2	Distilled "	1.37	0.23	1.14
	Surface "	0.46	0.29	0.17
" No. 3	Distilled "	1.03	0.46	0.57
	Surface "	0.40	0.18	0.22
" No. 4	Distilled "	1.14	0.29	0.85
	Surface "	0.91	0.23	0.68
" No. 5	Distilled "	8.51	7.14	1.37
	Surface "	5.83	5.57	0.26
" No. 6	Distilled "	1.20	0.74	0.46
	Surface "	0.17	0.17	0.00
" No. 7	Distilled "	1.31	1.14	0.17
	Surface "	0.51	0.45	0.06
Petroleum residuum	Distilled "	1.20	0.42	0.78
	Surface "	1.14	0.36	0.78

TABLE III.—Showing the Loss from Various Asphalts Exposed for Two Years to the Action of Distilled Water in Glass Jars.

(In grams per square meter of exposed surface.)

Asphalts.		Total solids.	Loss on ignition.	Fixed solids.
Trinidad Lake	Total	79.33	42.80	36.53
	In solution	19.25	4.77	14.48
Bermudez	Total	21.17	8.83	12.34
	In solution	16.67	6.17	10.50
Alcatraz D	Total	21.42	5.92	15.50
	In solution	18.67	3.92	14.75
XX	Total	6.33	3.42	2.91
	In solution	4.50	2.75	1.75
Maltha No. 1	Total	11.76	6.59	5.17
	In solution	5.92	2.50	3.42
Maltha No. 2	Total	12.42	8.62	3.80
	In solution	10.08	6.17	3.91
Cuban No. 1	Total	3.75	1.50	2.25
	In solution	3.75	1.50	2.25
Cuban No. 2	Total	2.83	0.92	1.91
	In solution	2.83	0.92	1.91
Assyrian No. 2	Total	5.17	4.67	0.50
	In solution	5.17	4.67	0.50
" No. 3	Total	9.25	4.85	4.40
	In solution	9.25	4.85	4.40
" No. 4	Total	9.75	5.75	4.00
	In solution	6.83	5.17	1.66
" No. 5	Total	17.93	16.17	1.76
	In solution	17.93	16.17	1.76
" No. 6	Total	8.92	3.17	5.75
	In solution	4.58	2.83	1.75
" No. 7	Total	9.08	4.83	4.25
	In solution	6.08	3.17	2.91
Asphaltina	Total	4.75	3.13	1.62
	In solution	3.67	2.92	0.75
Asphaltina and Cuban	Total	8.08	4.17	3.91
	In solution	8.08	3.92	4.16
Petroleum residuum	Total	2.25	2.08	0.17
	In solution	2.25	2.08	0.17

water. The water over the Trinidad asphalt contained more soluble matter than most of the other samples and this asphalt was acted upon the most strongly. The correspondence between action of water and soluble matter was not perfect, however. Assyrian asphalt No. 5 gave up a phenomenally large amount of soluble matter in proportion to the extent of the surface action, while a few of the asphalts that were apparently unacted upon gave up some soluble matter, both organic and mineral.

The results of the experiments made to determine the soluble constituents of the asphalts are given in Tables II., III. and IV.

In Table III. are given the results of the analyses of the distilled water made at the end of two years. The total solids and loss on ignition were made both before and after filtration through paper, in order to separate the material in suspension from that in solution. The results are naturally higher than those given in Table II., but they present but few additional points of interest. In the case of the Trinidad asphalt it will be observed that most of the matter is in suspension. This shows in a general way the greater amount of disintegration that has taken place.

The organic matter represented by the loss on ignition was asphaltic in character. During ignition it blackened and gave off the characteristic odor. This odor could be detected in the waters in the jars, and was found to correspond in intensity to the amount of action that had taken place. Some idea of the character of the fixed solids may be obtained from Table IV.

The results of the second series of experiments are given in Table V., which shows the increase in weight of each sample after exposures of one day, one week and two months. The results are expressed in "grams per square meter of exposed surface."

The greatest increase of weight was observed in the case of the Trinidad asphalt. The sample exposed in Mt. Prospect Reservoir gained 3.92 grams per square meter in one day; after two months it had gained 31.24 grams. The gain in weight varied with the conditions of exposure. In the conduit at Freeport the gain in weight during two months was 84.41 grams; in Mt. Prospect stand-pipe, where the pressure was great, it was 137.09 grams. This is equivalent to a gain in weight of 4 oz. per sq. yd. of exposed surface.

The gain in weight of the other samples was less, but corresponded, in a general way, with the amount of action observed.

Richardson has also observed that asphalt gains in weight when exposed to the action of water. In his paper on "Softening Agents for the Production of Asphaltic Cement,"* he says:

> Surfaces of the pure bitumen from asphalt, of the asphalt cement made with it and residuum, and of coal tar, were prepared in glass beakers, each having an area of 16 sq. cm. These surfaces were covered with water and exposed to its action for a year, being weighed at intervals.

The results are given in the following table, recalculated from the original figures, and expressed in grams per square meter of exposed surface:

TABLE VI.—Showing the Gain in Weight of Bermudez Refined Asphalt, Bermudez Asphalt Cement and Coal Tar, During Different Periods of Time. (Recalculated from Richardson.) (In grams per square meter of exposed surface.)

	Time elapsed.						
	One week.	Months 1.	2.	4.	6.	9.	12.
Bermudez refined asp..	2.5	10.6	15.6	34.4	36.9	47.5	60.0
Asphalt cement	0.8	13.7	30.0	36.3	39.4	50.0	65.7
Coal tar	1.3	13.2	14.5	28.9	29.4	32.5	44.4

It will be seen from this table that the asphalt cement was slightly more acted upon than the refined asphalt, and that the coal tar was acted upon the least.

The cause of the action of water upon asphalt appears to be in part chemical and in part physical. In the article just quoted Richardson has suggested that the molecular structure of the asphalts is an important consideration. He has given a table showing the relative effects of different strengths of sulphuric acid upon petroleum residuum, Alcatraz maltha and the hard Alcatraz asphalt, from which it is seen that the maltha and hard asphalt are less saturated in their composition than the petroleum residuum, and are acted upon more strongly by sulphuric acid.

In consequence it is but reasonable to suppose that the same relations exist in their ability to withstand the action of water.

*Municipal Engineering, June, July, August, 1897.

TABLE IV.—Showing some of the Mineral Constituents Given up by the Trinidad, Bermudez and Alcatraz D Asphalts During an Exposure of Two Months in Glass Jars.

Asphalt.	Water.	Fixed solids.	Sodium chloride (Na Cl)	Carbonates and sulphates of calc. & mag.	Oxide of iron (Fe_2O_3)
Trinidad Lake	Distilled	1.81	0.42	0.48	0.06
	Surface	1.20	0.00	0.42	0.12
	Ground	1.51	0.60	0.42	0.06
Bermudez....	Distilled	1.51	0.18	0.00	0.00
	Surface	0.96	0.17	0.05	0.00
	Ground	0.28	0.09	0.00	0.00
Alcatraz D...	Distilled	0.54	0.00	0.00	0.00
	Surface	0.64	0.00	0.00	0.00

The saturated and permanent character of the residuum as compared to the maltha and asphalt is also shown by their ultimate composition.

	Carbon	Hydrogen.
Residuum after treament with acid....	84.74	15.33
Maltha after treatment with acid	86.86	13.10
Asphalt	88.25	11.75

The residuum has the composition of a saturated hydrocarbon, while the maltha and asphalt have that of the unsaturated series.

Asphalt has the property of physically absorbing a certain amount of water. This accounts in part for the increase in weight given in the above tables. It has been found that if the brown, punky material is removed from the surface of asphalt which has been acted upon, and is kept for several days in the desiccator over sulphuric acid, it will lose weight on drying at 100° C. In the case of Trinidad asphalt this loss is about 0.8% of the original weight. Not all of the water is driven off at this temperature, but enough is removed so that a definite change takes place, for the material changes from a brown, inert powder to an elastic substance with apparently the properties of the original asphalt, except that the color when powdered is very dark brown instead of black. That it has not exactly the same composition as the original asphalt, however, was shown by the following experiment. Portions of this dark brown material and of the original Trinidad asphalt were dried for six hours at 100° C. and compared by making combustions of each in a Mahler Bomb Calorimeter. The following results were obtained:

	After heating at 100°C. Original asphalt.	After heating at 100°C. Asphalt acted upon by water.
B. T. U.....	10,246	10,042
Ash...	37.7%	36.8%
Nitrogen	1.97%	1.92%
Volatile sulphur..... ..	3.51%	3.10%

It will be seen that there was a loss of about 200 B. T. U., and a loss of 0.4% of sulphur. This loss in sulphur does not entirely account for the loss in B. T. U., and it must be assumed that, in the course of the action by the water, the asphalt became oxidized and that a change occurred beyond that to be accounted for by the loss in sulphur.

As a check upon this result the same experiment was repeated, but this time the substances were first heated for two hours at 110° C. At the end of this time the samples had lost from 1.4% to 2.4% in weight, showing by these varying amounts that the water present was probably not in chemical combination. At the same time oxygen had been taken up in the heating, as shown by the loss in heat units.

The following table shows the same relative results as the previous one:

	After heating at 100°C. Original asphalt.	After heating at 100°C. Asphalt acted upon by water.
B. T. U.	10,112	9,974
Ash	37.57%	35.39%
Nitrogen	2.13%	1.95%
Volatile sulphur	3.48%	2.94%

It will be seen from this table that the asphalt, in spite of the fact that it had lost over one per cent. more water than in the first experiment, decreased in B. T. U., showing that it had taken on a considerable amount of oxygen.

Endemann* has noted the avidity with which asphalt absorbs oxygen at high temperatures and the change in its physical condition when heated at 250° C. in a current of air.

As tests for hydrogen sulphide have been found in water which has stood for some time over asphalt it must be concluded that to this extent the water itself acts chemically upon the asphalt, and that some of the loosely combined sulphur is replaced by oxygen, with the consequent liberation of hydrogen sulphide.

Throughout the course of the investigation it was observed that the waters that contained the smallest amounts of mineral matter produced the greatest action upon the asphalts. Sea water gave but little action. In order to obtain comparative results upon this point, samples of various asphalts were subjected to the action of distilled water, sea water and a concentrated brine solution in glass jars. After two months it was found that the distilled water showed considerable action, the sea-water a very slight action and the brine no apparent action.

Some of the brine solution was also allowed to stand over the surface of an asphalt that had been already acted upon by water. No change in the brown material took place. This seemed to indicate that the salt itself exerted no chemical action upon the asphalt.

A determination of the dissolved oxygen in the distilled water, sea-water and brine gave the following results in cubic centimeters of dissolved oxygen per liter: Distilled water, 7.1; sea-water, 4.8; brine, 0.6.

These facts show conclusively that the action of water upon asphalt is largely one of oxidation and is due to the oxygen dissolved in the water. As a final test, however, a sample of Trinidad asphalt was covered with water which had been boiled until free from oxygen, and then tightly sealed to prevent absorption from the air. The action that took place under these conditions was very slight. It appears, therefore, that water acts chiefly as a carrier of oxygen, and does not to any great extent give up the oxygen of its own composition.

As a practical example of the effect of water upon asphalt used for reservoir lining, the following is perhaps the best instance that can be cited. About eight years ago the reservoirs of the Citizens' Water Co., of Denver, Colo., were lined with asphalt. These reservoirs, known as the East and West Ashland Avenue Reservoirs, have the following dimensions:

West Reservoir, bottom, 341 by 256 ft.; top, 330 by 420 ft.; maximum depth, 32 ft.; side slopes, 1.33 to 1; capacity, 22,000,000 gallons. East Reservoir, bottom, 152 by 494 ft.; top, 230 by 580 ft.; depth, slopes and capacity, the same as the West Reservoir.

The West Reservoir was lined with Trinidad asphalt in 1891; the East Reservoir was lined with California asphalt in the summer of 1892.*

In 1893 Schuyler stated that the reservoir which was lined with Alcatraz asphalt was in good condition, while the reservoir which was lined with Trinidad had shown signs of deterioration. At the present time, however, both reservoirs are in a very unsatisfactory condition. The appearance of the asphalt linings is shown by the four samples kindly furnished by Mr. C. P. Allen, Chief Engineer of the Denver Union Water Co. The samples represent the condition of the surface of the asphalt in each reservoir above and below the line of high water.

The following asphalts and fluxes are arranged in the order of least to greatest action by water:

Petroleum residuum.	Alcatraz maltha, No. 1.
Assyrian asphalt.	Alcatraz asphalt, D.
Asphaltina.	Alcatraz asphalt, XX.
Cuban asphalt.	Bermudez asphalt.
Alcatraz maltha, No. 2.	Trinidad Lake asphalt.

The action of water upon asphalt is due to the unsaturated nature of the hydrocarbons present, and is attended by a partial solution of the asphalt in the water. There is also a loss of sulphur as hydrogen sulphide, and an increase in weight of the asphalt itself due to oxidation and to the mechanical admixture of water. By far the most important action which occurs is that produced by this oxidation of the asphalt by means of the dissolved oxygen in the water.

The authors desire to express their thanks to Mr. Robert Van Buren, Engineer in Charge, Department of Water Supply, Brooklyn, for permission to quote from unpublished reports of the laboratory, and to Mr. I. M. De Varona, Engineer of Water Supply, under whose direction the experiments on asphalt were begun.

*"The Analysis of Asphalt," Journal of the Society of Chemical Industry, Vol. XV., No. 12, Dec., 1896; and Vol. XVI., No. 2, Feb., 1897.

TABLE V.—Showing the Increase in Weight of Various Asphalts During Exposure to Waters of Different Quality and Under Different Conditions.

(In grams per square meter of exposed surface.)

Time of exposure .....1 day.		1 w'k.	2 mos.
Trinidad Lake	Conduit at Freeport	.....	84.41
	Mt. Prospect Resvr.	3.92	21.54	31.24
	" stand-p.	5.25	34.79	137.09
Bermudez....	Conduit at Freeport	.....	4.86
	Mt. Prospect rearvr.	1.02	3.88	5.96
	" stand-p.	7.71	8.42	11.02
Alcatraz, D...	Conduit at Freeport	.....	5.86
	Mt. Prospect reservr.	1.09	3.50	6.93
	" stand-p.	1.81	4.77	10.39
Alcatraz XX..	Mt. Prospect stand-pipe	....	2.82	...
Maltha No. 2		....	4.73	8.65
Cuban No. 2..		....	4.91	7.17*
Assyrian No. 2		....	1.79	2.54*
" No. 3	Mt. Prospect reser.	....	1.22	1.54*
" No. 4		....	0.74	3.41
" No. 7		....	0.93	1.12*

*One month.

A FIRE TEST OF A FIREPROOF SAFE was made at the testing plant of the British Fire Prevention Committee in London, Oct. 18, 1899. The test was made to record the effect of a fire of 1½ hrs. duration, commencing with a temperature of 500° F., gradually increasing to a temperature of 1,800° F., followed by the application of a stream of cold water for three minutes. The safe was 25 ins. high, 19 ins. wide, and 19 ins. deep. To all outward appearances the walls, floor and roof of the safe were of steel, ⅝-in. thick, reinforced with an inner casing, 2¼ ins. thick, making a total of 2⅞ ins. The door appeared to be ⅝-in. steel plate with an inner casing of 4¼ ins., making a total thickness of 4⅝ ins. The inner casing was apparently packed with some non-conducting material, such as slag wool, etc. There were 3 bolts, 2 ins. deep, ⅝-in. thick, and the lock was a "powder-proof" solid lock. The safe was painted inside and outside. The result of the test was as follows: The paint on safe at once blistered, rolled up, and disappeared within 15 mins. In 60 mins. the upper part of the safe was becoming red hot. In 75 mins. the upper part was intensely red hot. In 85 mins. the contents burned, flames issued from sides and top of door; the two sides of safe had bulged outwards. On the safe being broken open, two days after the test, the contents were found burnt to tinder. The slag wool packing was found sintered and hardened all over, and the contents, consisting of a newspaper and a paper-covered book, were burned to a cinder.

THE KINGSBRIDGE POWER STATION OF THE THIRD AVENUE RY., NEW YORK CITY.

By Burcham Harding.*

The central power station now in course of construction for the Third Avenue Ry. Co., New York city, will contain one of the largest installations of electric current generating machinery in the world. The foundations of the power house are nearly completed. It is situated at 216th St. and 9th Ave. Although this location is somewhat north of the present load center of the system, it must be remembered that New York city is rapidly growing in a northerly direction, and the station is contiguous to the lines of the Union Street Ry., which it will supply with current. The site selected allows freedom in station design and more space, and promises better results than would have been possible had a site been chosen farther down town. The Harlem River is close at hand for condensing purposes, while fuel and supplies can be brought directly to the station by water, or to within a short distance by the New York Central R. R. From the central station three-phase current will be transmitted to five or more rotary-converter substations, the positions of which have not yet been finally decided upon. An auxiliary storage battery station will also be provided at 66th St. and Tenth Ave.

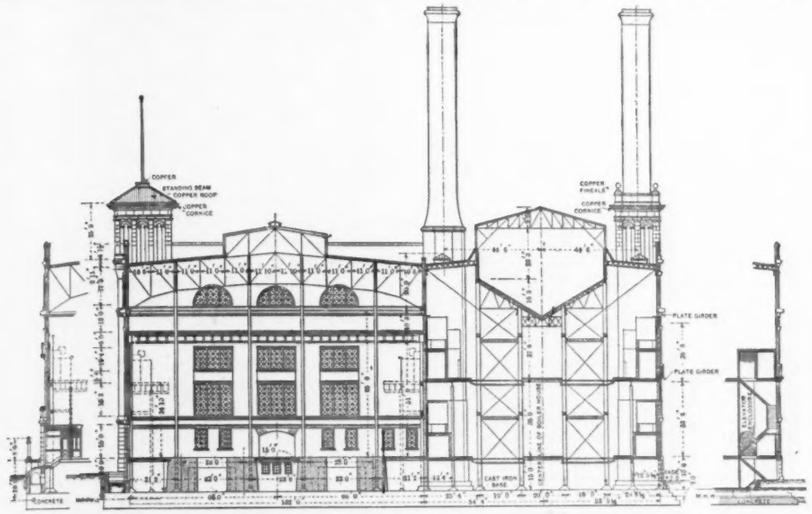


FIG. 1.—FRONT ELEVATION AND SECTION OF THE KINGSBRIDGE POWER HOUSE OF THE THIRD AVE. RY., NEW YORK CITY.

Westinghouse, Church, Kerr & Co., New York City, Engineers and Contractors.

The power station will contain 16 main generating units, aggregating 72,000 HP. as usually rated, and over 100,000 HP. maximum.

The plan of the power station is shown in Fig. 2. Its general scheme involves a division of the plant into four sections of four-power units each. Each section is served with steam by a double-decked battery of boilers occupying one-quarter of the boiler-house. Each quarter, in turn, has its independent flues, economizers, stack and auxiliary mechanical draft. From each section, also, a main exhaust leads to one of the four condensers. Equalizing flues are provided to allow each stack, with the aid of mechanical draft, to relay the other stack on the same side of the house. The steam piping, constructed upon the equalizing main system, is so connected as to allow each section to relay each of the other three, while the four condensers can work as one unit, three having the requisite capacity to admit of one being cut out. The main aisles of engine and boiler rooms are intersected by a wide transverse aisle to gain room for the concentration of auxiliary apparatus and connections at the center of the plant. The switchboards are carried upon elevated structures along the side walls, about 80 ft. in length on each side, and their galleries connect to the engine galleries and to a transverse bridge spanning the engine-room in the middle.

The building covers the entire distance between 216th to 218th streets, on the east side of 9th Ave., and extends back about 250 ft. to the dock on the Harlem River. The masonry and steel-work have been so designed as to make each part as efficient as circumstances permit, the walls carrying their own dead load up to the height of the second floor line, but being supported by the wall columns from the effect of exterior forces such as wind pressures. All portions of the building are well lighted and ventilated, the light openings in engine-room amounting to 1 sq. ft. for each 1.8 sq. ft. of floor space. An excavation, 350 ft. long, on Ninth Ave., 270 ft. in width and 14 ft. in depth, has already been prepared. In this excavation some 15,000 to 16,000 oak piles, 40 ft. long, and spaced about 2 ft. 4 ins. between centers, have been driven. The soil at the site is a very fine, sharp sand, and owing to this circumstance the piles were driven by the aid of jets of water. The water is conveyed to the point of use in pipes under pressure, and these pipes are thrust down alongside the pile as it is being driven, loosening the sand so that driving is rendered comparatively easy. The operation occupies about 10 minutes for each pile.

Resting upon the piles is the concrete foundation, which is from 7½ to 8 ft. in thickness, and extends over the entire surface of the piles. The concrete is composed of one part Portland cement, two of sand, and four of stone. The bearing weight on the concrete foundation will be from 2 to 15 tons per sq. ft.

The basement floor line is placed at a grade, well above the highest tide ever recorded, to ensure absolute dryness at all times. Below this floor line, in the concrete foundation, tunnels will be built for the intake and overflow water for condensation, the former being brought through large cast-iron pipes to four large centrifugal circulating pumps, and the latter flowing out in a covered channel built in the concrete itself. The intakes are brought to the suction wells immediately outside the building. They approach from the extreme corners of the property, and are thus kept as far away from the warm overflow as possible, the latter flowing into the center of the slip as a precaution against the formation of ice in the coldest winter weather. All the floor drains are also embedded in this foundation. Fig. 1 shows a transverse section of the power station.

In the basement, space has been provided for a machine shop for light repair work, and there is accommodation of lockers and toilet rooms for the power house employes. Most of the auxiliary apparatus is to be placed in the boiler-house basement, while the space around the main engine foundations is reserved for the main steam and vacuum connections, and for other piping systems. The engine-room floor and the first floor or boiler-room are on the same level, which is 15 ft. above the basement floor. Above the second floor boilers, supported on a series of columns rising through the boiler-house, is the coal pocket of large capacity, extending the full length of the building, from which coal is fed by gravity to the furnaces, as described elsewhere. An elevator running from the basement to the coal pocket will serve the various floors of the boiler plant, for convenience in handling apparatus and other materials of moderate weight.

Two 50-ton electric traveling cranes will span the engine-room. Each of these cranes will have a main hoist of 50 tons, with an auxiliary hoist of 15 tons for handling small parts of apparatus at high speed. The principal features of the steam plant are in outline as follows:

Engines.

These are under construction at the works of the Westinghouse Machine Co., at Pittsburg, Pa., and are of the vertical, cross-compound condensing type, with the generators mounted on the shaft between the cylinders. They are of 4,500 HP. each, at 75 revs. per min., with a maximum capacity of about 7,000 HP. The cylinders are 46 ins. and 86 ins. × 60 ins., and will be mounted on very heavy rectangular section housings, supported by box-type bedplates.

The cylinder heads will be of the box pattern, carrying the steam and exhaust valves and passages. The pistons and followers will be built up of cast steel, and steel plates with cast-iron wearing and packing rings. The piston rods will be of open-hearth steel, 9 ins. and 10 ins. in diameter, fitted with double split metallic packing.

The valves will be of the rolling type, double ported, supported by large bearings and intermediate bridges. They will be operated by releasing-valve gear and designed to permit carrying steam to ¾ stroke, with rapid release at this extended cut-off. The exhaust and steam valves will be driven by separate eccentrics on both high and low cylinders, and provision made for disconnection of wrist plates for hand operation by means of a steam or hydraulic cylinder.

The governor will be of the heavy-weighted pendulum type, connected to both high and low pressure gears with hand adjustment; also with a device for adjusting the speed from the switchboard. The cross-heads will be of cast steel, turned type, with wedge adjusted babbit-faced shoes, and fitted with 14-in. pins. The connecting rods will be 12 ft. 6 ins. long from center to center, of open-hearth steel, with solid ends, fitted with bronze cross-head-pin boxes and babbit-lined cast iron, crank-pin boxes. The eccentrics will be of cast iron, split and fitted with scraped babbit-lined cast-iron straps, all enclosed in sheet-steel casings, provided with doors for access.

The main shaft journals will be 60 ins. long, the lower shells of the ball and socket type, bearing on the bedplate about one-third of their length, and will be fitted for water circulation. The caps will be in two pieces. The shells will be removable by raising the shaft ¼-in. The cranks will be overhung, of the fantail type, and of cast steel, bored for a 30-in. fit 19 ins. long, and forced in place by hydraulic pressure. The shaft will have a maximum diameter of 39 ins. and a length of about 27 ft.

The receiver will contain a reheater of the type in which the live steam circulates around the reheater pipes. It will be of boiler steel, with double-riveted flanged heads, covered and lagged. It will be carried close to the frame upon brackets. The flywheel will be of the built-up type, about 28 ft. in diameter, composed of a cast-iron center, cast-steel segments, linked together and bound by steel reinforcing plates. The wheel will be directly attached to the revolving element of the generator. The exhaust connection will be 30 ins. diameter, while the steam connection will be 14 ins., fitted with a semi-balanced throttle with pilot valve, also a balanced safety stop valve arranged to shut off automatically at a predetermined increase of speed. It will also be operative from any designated point. Two galleries will be provided; one level with the top of the housings, from which a stairway leads to the upper one on a level with the lower side of the cylinder heads. The upper gallery is connected across from high to low pressure side, and from engine to engine. Indicator motion, oil shields, oil drains, and various oiling devices are supplied.

*Pittsburg, Pa.

Boilers.

The boiler equipment consists of 60 Babcock & Wilcox water-tube boilers of 520 HP. each, set in batteries, with the upper tier corresponding with the lower in setting and arrangement. They are of the standard construction usual to such boilers, fitted with forged headers, and adapted for 200-lb. working pressure. The boilers are hung from steel beams, supported by and forming part of the building structure, not only independent of the brick work, but of the floors, also.

Mechanical Stokers.

The boilers are to be equipped with the Roney mechanical stoker and smokeless furnace, capable of burning either hard or soft coal, separately or mixed, as may be desired. The coal may be dumped into the pocket indiscriminately, and the hard and soft coal may be piled together and be burned by the stokers as it is drawn from the pocket.

In a power plant of this size, the number of men that would be required to operate flat grades, the rapidity with which changes of load come upon the station, and the large quantities of coal to be handled, almost preclude the use of anything but mechanical firing.

Condensing Plant.

After much consideration it was decided to adopt a central elevated jet plant, comprising the essential features of a central surface condensing system, except such as pertained strictly to the surface condensers, and so arranged as to admit of the substitution of surface condensation at such time as it may be desired to reclaim the feed water, which in this plant will cost over $100,000 per annum. The large exhaust trunks, 54 ins. in diameter, lead from the four sections, each serving four engines. Provision is made for free exhaust for each pair of sections through a smaller auxiliary trunk, carried through the roof independently. The main trunks lead to their respective elevated jet condensers of the Worthington type, and are so arranged as to enable any three to carry the full load, while one is cut out for cleaning or repair, or any one may be cut out singly, to prevent abnormal leakage on any trunk from affecting the vacuum on the others. The condensers are operated on the dry air system, the injection water being handled by four large centrifugal pumps, operated by Westinghouse compound engines, which serve the condenser heads at an elevation of about 48 ft. The water passes through elevated air coolers, where it surrounds brass pipes in which the air is cooled until its volume is reduced about one-half; it is then exhausted and the vacuum maintained by close clearance air pumps of the flywheel type, with positively actuated valves.

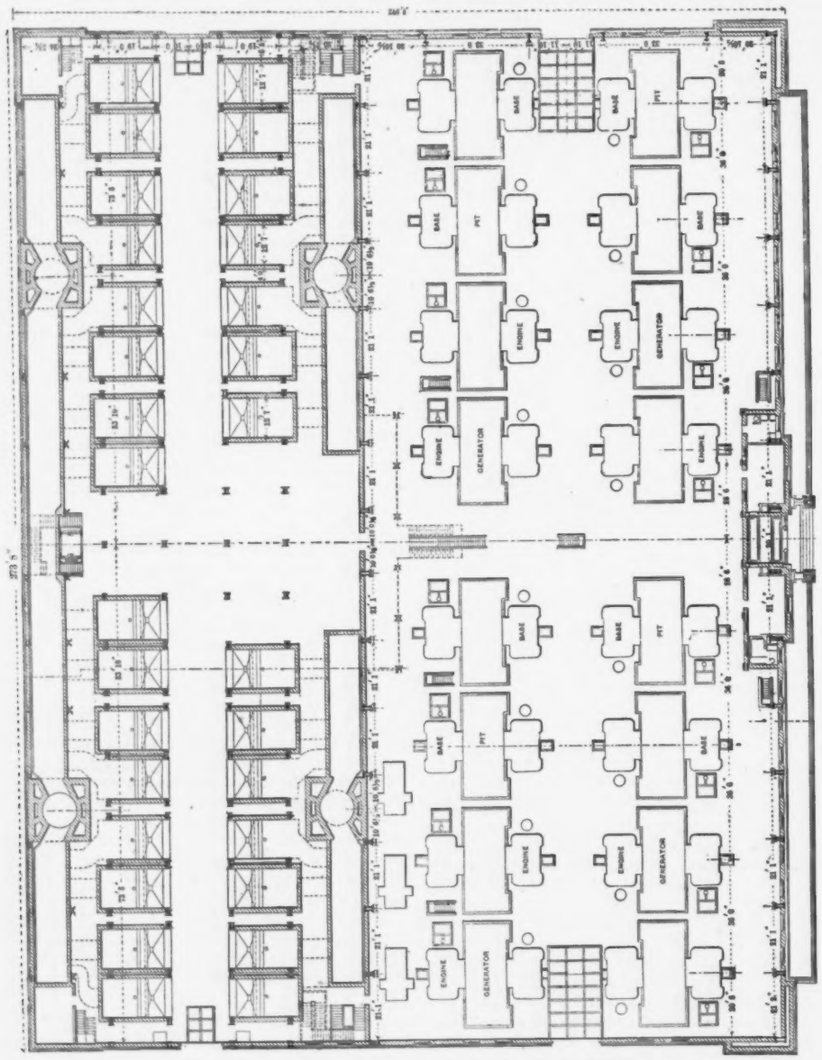


FIG. 2.—PLAN OF KINGSBRIDGE POWER HOUSE.

Coal Handling Machineery and Coal Pocket.

The coal handling machinery is to consist of an elevated unloading plant on the dock, with power shovel and hoisting machinery, which will discharge the coal into a hopper on the upper floor of the tower. From this point the coal will be spouted to two crushers on the lower floor, which discharge by gravity to the conveyors. From the crushers the coal is to be taken by conveying and elevating machinery of the wheel and bucket type, and deposited in the coal bunkers above the boilers. From the bunkers it will feed by gravity to the stokers. Coal conveyors from the unloading plant on the wharf of the boiler-house will be worked by electric motors, and are also arranged to convey the ashes. The coal bin extends the entire length of the boiler-house, and is of masonry and steel construction, the beams being protected from heat due to possible internal fires by the concrete bottom. The pocket has a storage capacity of 12,000 tons of coal, and is so arranged that the coal in storage will be constantly in motion, due to drawing by gravity from the bottom; and in case of fire the tight masonry and beam construction, of which the bottom of the pocket is composed, will enable water to be freely used without interrupting the operation of the boilers. The coal chutes in the bottom of the coal bin are over the center of the upper fire room, 16 outlets being provided.

Draft Plant.

This will consist of four stacks, each 12¾ ft. in diameter and 98 ft high, and eight large slow-speed exhaust fans for producing draft in case of overloads. Each fan is capable of producing draft for an installation of 4,000 HP. of boilers at nominal rating, and equal to that of a stack 500 ft. high, with proper flue and with all boilers and economizers in service.

Fuel Economizers.

The economizers are of the high pressure type, aggregating 9,600 pipes, being 16 in number, each containing 600 tubes, and having a total surface of 96,000 sq. ft. Self-acting scrapers are to be provided for cleaning the exterior surface of tubes, and are to be actuated by an automatic scraper gear driven from the fan shafts.

These economizers are to be capable of raising the temperature of the feed water 140° F. from an initial temperature of 105° F., when all the boilers are operating at or above their rating. They will take from the waste gases an amount of heat which represents from 10% to 15% of the coal burned on the grates, the amount varying with the amount of load, with the rate of combustion and with other things which vary from time to time. It is estimated that the first cost and operating expenses of the economizers and mechanical draft apparatus will show an annual saving of $65,000, representing 75% on the investment.

Boiler Feed System.

The boiler feed pumps are to be of the H. R. Worthington make, five in number, of heavy construction and special design, having compound steam ends and outside packed plungers in "pot valve" or "pressure pattern" water ends. The primary heaters are to be four in number, of the closed type, and each of 6,000 HP. rated capacity. The closed auxiliary feed water heaters will be of suitable size to utilize completely the heat of the exhaust of the steam auxiliaries.

The feed water mains are to be in duplicate, except the branches to the individual economizers, to the auxiliary heaters, and to the boilers. The water will be carried to the pumps in a duplicate suction main, each branch being of ample capacity for the whole installation. The discharge mains from the pumps will be in duplicate, and will be carried to the primary heaters, where inlet connections from each main will be made to each heater.

The discharge from the primary heaters will be in duplicate, making separate connections to duplicate intermediate headers, which will be carried full size entirely around the boiler-house, being suspended from the boiler-room floor which carries the upper tier of boilers. The mains will also be provided with stop valves, so that they may be divided into sections. Individual connections will be made from each of these mains to a branch leading to each economizer, and there will be provided by-passes connecting these mains to the discharge mains from the pumps, cutting out all the primary heaters. Feed water from the primary heaters will discharge through the auxiliary heaters and deliver to each of these mains.

The discharge from each economizer will con-

nect by a single branch to each line of a duplicate high-temperature main, which will extend full size entirely around the boiler-house, and will be suspended immediately under the fronts of the upper tier of boilers. By-passes will be provided from the intermediate mains, connecting them directly to the high-temperature mains, so that water may pass from one to the other without going through the economizers. These by-passes will be provided with automatic valves to compensate for changes in resistance due to cutting off economizers. This main will also be provided with cut-off valves, so that it may be used in two sections.

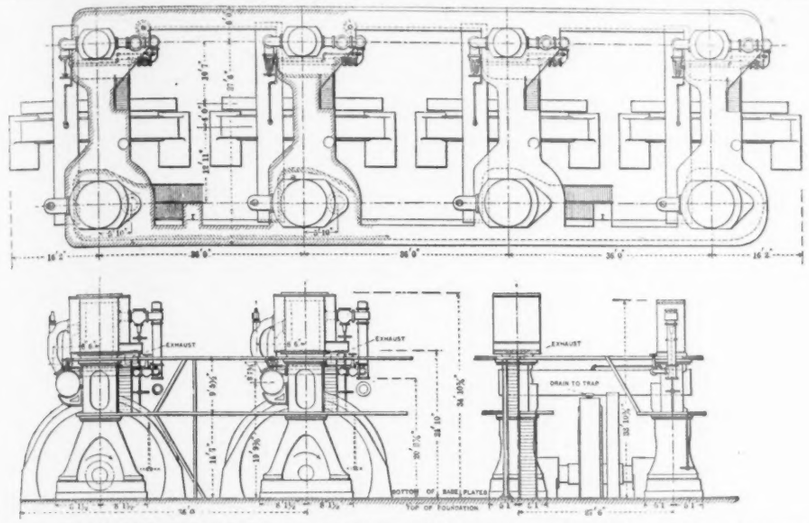


FIG. 3.—PLAN AND ELEVATION OF 4,500-HP. ENGINES AND GENERATORS FOR KINGSBRIDGE POWER HOUSE.

Oiling Systems.

An oiling system of the gravity flow type is to be installed, with full complement of flow pipes to take lubricating oils from the two central elevated storage tanks to the bearings of the main generators, and return the dirty oil therefrom to two central filter plants, where it is to be cleansed and returned by small pumps to the storage reservoirs. The filters are to be of the double gravity type, wherein the oil settles by gravity through bags of close woven fabrics into tanks of sufficient depth to contain about 15 ins. of water in the bottom beneath the oil. The bags will remove the larger particles of dirt, while the smaller abraded materials will fall by gravity through the water and be retained on the bottom of the tank. Filters are to be so arranged that they may be cleaned without interrupting the service. The oil pumps will be in duplicate, there being two complete systems, each serving one-half of the plant.

The cylinder oil is to be brought to the lubricators on the engine by a system of piping from a tank well elevated in a warm place in the boiler-house. This will enable the lubricators to be filled by simply draining the lubricator oil through a drip pipe, which will be provided for the purpose, and then allowing the cylinder oil to flow into the lubricating tank or receiver, thus avoiding the numerous troubles incident to attempting to feed continuously under pressure. A closed tank and a connection with the air cleaning system are to be provided for forcing the cylinder oil up to the supply tank, the oil flowing from the barrels in which it will arrive into this closed tank by gravity.

The electrical equipment, including sixteen 3-phase generators, transformers, rotary converters and the necessary switchboards and controlling apparatus will be supplied by the Westinghouse Electric & Mfg. Co., of Pittsburg, Pa. Westinghouse, Church, Kerr & Co., of New York city, are the engineers and contractors for the entire plant.

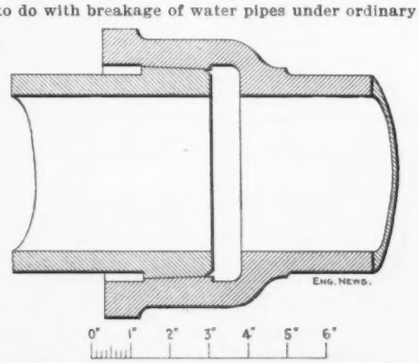
WEIGHTS AND JOINTS OF CAST-IRON WATER-PIPE.

At last week's meeting of the New England Water-Works Association, some interesting information was presented in two short papers. The first, "Some Notes on Cast-Iron Water Pipe," was by Mr. Freeman C. Coffin, M. Am. Soc. C. E., of Boston; and the other, on "Wooden Joints in Cast-Iron Water Pipe," was by Mr. William Murdoch, Engineer and Superintendent of Water-Works and Sewers, St. John, N. B.

Mr. Coffin said that a comparison of the standard weights of pipe given by two foundries, and those given by the Boston Water Department and the late M. M. Tidd, shows the following differences expressed as percentages, the figures in each case being for 12-ft. lengths and a 200-ft. head:

Pipe, size.	Difference between, %: Two foundries.	Two engineers.	Pipe, size.	Difference between, %: Two foundries.	Two engineers.
4 ins. diam.,	21.5	20.0	14 ins. diam.,	28	..
6 " "	18.5	13.5	16 " "	29	10
8 " "	23.5	13.5	20 " "	29	8
10 " "	20.5	12.5	24 " "	39	6
12 " "	26.5	11.0			

Mr. Coffin believes as a result of his experience and observation that water pressure has but little to do with breakage of water pipes under ordinary conditions, but does not intend this statement to apply to pressures of 150 lbs. per sq. in. or more. Any pipe which will stand the pressure test of 300 lbs. per sq. in. at the foundry, and withstand the shocks of transportation and handling until laid, will probably sustain the water pressure, and the proper thickness for economy will be that at which any further saving in iron by reducing the thickness would be balanced by breakage in handling. Pipes could then be classed as "light," "standard," or "heavy;" and if some standard specifications could be adopted, for instance, a set which should be endorsed by the New England Water-Works Association, with all requirements thus reduced to their lowest terms, it would be possible to ask for bids or to place orders by telegraph without excessive expense.



Section of 4-in. Bored and Turned Cast-Iron Pipe Joint Used at Yarmouth, N. S.
Montreal Pipe & Foundry Co., Ltd., Londonderry, N. S., Manufacturers.

Mr. Coffin showed a sketch of a turned and bored pipe joint which is used at Yarmouth, N. S. (see cut). This pipe cost there about $5 per ton more than the ordinary bell and spigot pipe, and this more than counterbalanced the saving in lead. The superintendent of the Yarmouth Water-Works thinks the extra cost is more than offset by the ease with which this pipe is laid. Of course it centers itself in the bell, and no gasket is required. It is stated that ordinary deflections from line can be made as readily as with the ordinary joint.

Mr. Murdoch stated that the 12-in. main laid by his father in St. John in 1851 was jointed entirely with wood, excepting joints at specials or very unsymmetrical joints, for its whole length of 4½ miles. A 24-in. main laid about six years later was jointed in the same way. In 1873 another 24-in. main was laid, and about half of the joints were turned and bored, the remainder being either wood or lead. Of the three kinds the wood joints have proved the most satisfactory.

The experience with these joints having been so favorable, they were again used when laying a 24-in. main in St. John in 1899. The white pine staves cost 13 cts. per joint, and the total cost, including material and labor, was about 70 cts. per joint. The rate of wages was $1.20 per day.

Samples of the wood joints from the old 12 and 24-in. mains, which had been removed after 45 and 40 years' service, were shown, and were in almost perfect condition. In our issue of July 20, 1899, we published a note describing these joints, and suggested that the use of wood in place of lead joints might aid in solving the electrolysis problem; although this problem falls properly on those responsible for electrical currents, rather than water or gas works officials.

PRACTICAL HINTS ON THE DESIGN OF COMPRESSED AIR PLANTS.

Some good ideas in connection with the installation of compressed air machinery are given in a circular letter recently sent out by Mr. J. L. Pilling, M. E., Representative of the Q. & C. Co., of Chicago. We reprint the substance of it as follows:

It has been my privilege to visit about all the establishments where compressed air is used in the United States, and, with very few exceptions, I have not seen a properly constructed air plant anywhere.

The theoretical points of air compression have been understood from time immemorial, but the most essential, practical and economical points which are in demand today have not been touched upon, so far as I have been able to ascertain.

Compressed air will go as much below its normal temperature in expansion as it goes above in compression; therefore, the larger the exhaust port and shorter the exhaust passage, the less liability of icing up the tool.

Air compressors are as near perfect as we may expect to see them for years to come. The trouble lies not in the compressor, but the manner in which the compressor is connected up to the receiver and air taken therefrom. The principal use of a receiver is not for storage, as many think. More important matters are its condensing surface, and its use to absorb the pulsations of the compressor.

An upright receiver is to be preferred, and the discharge pipe from the compressor should be connected near the top of the receiver. Take the outlet to the main line about 1 foot from the bottom of the receiver. Have the receiver so placed that the outside atmosphere can circulate around it. Have a blow-off cock with a very short connection at the bottom. If conditions are such that a horizontal receiver must be used, connect discharge from compressor on top of the receiver at one end; connect outlet to main line at the other end, but as low as possible, as long as it is above the fore and aft line of the receiver.

If under these conditions the air is still warm as it leaves the receiver, then the receiver is not large enough, or the compressor is too small, or both. (It is often well to place another receiver adjacent to where the most air is used.) This will hold good even if an intercooler is used as on a compound compressor. Precipitate the moisture in the receiver—that is what it is for. By so doing there will be no trouble with the main line freezing, and better results will be obtained from pneumatic tools. These are finely constructed pieces of machanism, and the use of dry air will increase their efficiency and lessen their wear and the cost of their repair.

TO COMMEMORATE THE FOUNDING OF WASHINGton, D. C., the 100th anniversary of which occurs in December, 1900, the Commission appointed has determined upon a form of exercises. They will lay a cornerstone for an enlarged Executive Mansion; they also recommend the laying out of a wide driveway through the Mall from the Capitol westward; though the latter plan is much objected to.

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ADVERTISING RATES: 20 cents a line. Want notices, special rates, see page XXI. Changes in standing advertisements must be received by Monday morning; new advertisements, Tuesday morning; transient advertisements by Wednesday morning.

A perusal of the preliminary report of the Municipal Lighting Commission of Baltimore suggests the idea that if that city would put its lighting on a proper basis, sufficient saving might result to the municipal treasury and to private consumers and taxpayers to go far towards paying the interest on the cost of the much-needed but long-deferred sewerage system. The price paid for public electric lighting in Baltimore has not been lowered for nine years, and that for gas lighting, either public or private, for twelve years. There has been no contract in force for supplying gas to public lamps since 1885, the city simply buying gas like any other consumer at $1.25 per 1,000 cu. ft., the amount consumed by 6,232 lamps being estimated on the basis of the amount burned by 70 metered lamps. Moreover, the company gives no service except to supply the gas and read these 70 meters, as a check against readings by the city. In other words, here is a great wholesale consumer of gas, whose total bill for the year 1900 will be $108,000, paying the same rate to the gas company as the smallest private consumer. In addition to this example of the lack of ordinary business sagacity in the city, it pays its staff of lamp-lighters $10 a week for two hours' work each day, the same as municipal laborers on full time. After collecting and digesting statistics from other large cities, the lighting commission recommended that the city procure from the legislature power to regulate the charges for lighting and also authority to issue $1,350,000 of bonds for a municipal lighting plant. The latter power should be sought at once, it says, because the legislature does not meet again for two years. In a subsequent report the relative advisability of constructing a municipal plant, contracting with the present companies or granting a franchise to competing companies will be considered. The latter plan is held to be very undesirable, unless the others fail, the commission believing that competing plants would increase the cost of service in the future, as they have in Baltimore in the past. In case the bill for a franchise commission for Baltimore, noted in our issue of March 8, should pass the legislature, the rates for lighting would be regulated by the commission created.

The report of the lighting commission contains a variety of interesting facts and figures regarding lighting in Baltimore and other cities, and the subsequent report on municipal ownership promises to be full of interest. The members of the commission are as follows: Prof. Jacob H. Hollander; Chas. E. Phelps, Jr., and Edwin G. Boetjer.

It would be interesting to know just why a city that secures a large yearly rental from its street railway companies, as Baltimore does, should let its lighting companies have everything their own way, or at least appear to do so. Practically the whole expense of maintaining the park system of Baltimore is met by the revenue from the street railways. The attitude of Baltimore on the various matters mentioned, sewers, lighting and street railways, indicates that in the past its government has been of a hap-hazard nature, good at some points and bad at others.

An interesting report has just been made by the finance committee of the common council of Ithaca, N. Y., on propositions by the Ithaca Water-Works Co., to sell its works to the city or to enter into a long term contract for the continuation of its services. The chairman of the committee is Prof. R. H. Thurston, of Cornell University. Bearing in mind that the report is confessedly founded on limited technical data, it is to be considered as a good piece of work, forming a basis for a careful detailed study of the question, and for popular arguments pro and con. But there is one suggestion that needs modification. Assuming that the contract is renewed, it is proposed that there be

> assurance of supply to private consumers at a standard rate, as that of the city of Syracuse, or perhaps still better and more definite, if accepted as an alternative, on terms equivalent to the average throughout the State of New York, is a proposal so fair that, from this point of view, it is perhaps a matter of comparative indifference whether the "plant" be bought or the present system continued.

The chief objections to this plan are: (1) Water rates should be based on the cost of service and not on those charged elsewhere. (2) To agree that the rates should be the same as those in Syracuse, or any other one city, is bad enough, but to suggest as a more "definite" plan that they shall be "on terms equivalent to the average throughout the State of New York" sounds like "confusion worse confounded." Not long ago one of the courts at Denver, Colo., was engaged for weeks in an attempt to ascertain the average rate charged in only three cities, such an average having been made the basis of the rates to be charged in Denver. Somewhat earlier, it was shown in a suit in the United States Court at Des Moines, Ia., that there were some 70 to 80 variations in practice throughout the United States in the methods of assessing fixture rates for the ordinary household uses of water.

It is only fair to the members of the Ithaca committee to say, however, that their report clearly indicates that the Ithaca rates are much higher than either those at Syracuse or the average throughout the State, so that the proposed plan would appear to result in a decided reduction. The trouble is that in case of a hot controversy it is next to impossible to establish what average rates are, if either side contests the point. In the Des Moines case, the city brought in a few schedules from neighboring cities, sworn to by local officials, but imagine either side of a controversy at Ithaca bringing sworn affidavits of the rates charged by the four-hundred works in the State of New York! At Denver, witnesses from the three cities were put on the stand, and kept there for hours or days in the attempt to establish or disapprove facts relating to the water rates in those cities.

When the agitation at Ithaca passes beyond the preliminary stage we think the departments of engineering, economics and law at Cornell can suggest a better plan for fixing rates than that now proposed, which should not be considered too seriously in view of the fact that it is only tentative.

THE EFFECT OF DAMMING THE NIAGARA RIVER UPON THE LEVELS OF THE ST. LAWRENCE RIVER.

The proposition to regulate the level of Lake Erie by damming the Niagara River, which was fully outlined in our issues of Dec. 21, 1899 and Jan. 4, 1900, has aroused the concern of Canadians for the preservation of the navigable waterways of Lake Ontario and the St. Lawrence River. As most of our readers are doubtless aware, the Canadian Government has only recently completed at an enormous cost its chain of canals around the falls and rapids of the St. Lawrence River and the Great Lake waterways, by which it secures nominally a 14-ft. channel from the head of the Great Lakes to the Atlantic Ocean. Naturally, therefore, any proposition like the present one, which hints at a reduction of the water levels upon which these canals depend to maintain their depth is regarded by the Dominion engineers with suspicion. Prompted by this feeling, doubtless, they are now urging that the proposed plan to change the natural outflow of the Niagara River, which is, of course, certain to have some effect upon the levels of the waterways which it feeds, should be carefully investigated before it is approved by Canadian shipping interests.

No fair-minded person, we presume, will dispute the right of our Canadian friends to assume an attitude of caution toward a scheme which will possibly endanger their expensive system of artificial waterways along the St. Lawrence River. Indeed, the problem of lake regulation in all of its bearings is one of such wide concern that its discussion from every point of view should be encouraged. At the same time the undoubted benefit of regulating the upper lakes by some such method as has been proposed is so great that Canadian engineers cannot afford to take a narrow view of the problem.

It is important to keep in mind from the very outset that the problem is essentially an international one, and that the benefits of its successful solution will be enjoyed by both countries alike. To assume that the United States has in its plan to dam the Niagara River knowingly entered upon a deep laid scheme to benefit the upper lakes by shifting all the damage due to the change upon the Canadian waterways along the St. Lawrence is very short-sighted. The conditions of the problem render it extremely unlikely that any such solution could be arrived at even if it were contemplated. To attempt such a solution would be foolish as well as useless. We ask our Canadian friends not to be too ready to imagine duplicity, and to assume that the proposition of American engineers to regulate the level of Lake Erie by damming the Niagara River has been put forward by them in the belief that it will vastly benefit the navigation interests of the upper lakes without causing any relatively important injury to these same interests on the St. Lawrence River and Lake Ontario.

The line of argument which has been taken by Canadian engineers against the lake regulation project is quite fairly indicated by the following communications received by us within the last few weeks. These letters are both from engineers familiar with the St. Lawrence waterways, and are probably as fair an index of intelligent opinion in Canada as is at present available:

Sir: In the issue of Engineering News of Jan. 18, 1900, it is stated, with regard to the proposed regulating dam at the foot of Lake Erie, and the Chicago Drainage Canal, that it is doubtful whether the most accurate gagings will detect any difference of level in the St. Lawrence at Montreal as a result of these works. I can quite agree with you that any record that might be kept, after these works were completed, of the heights of the water surface would not detect any difference of level at Montreal, for so many other things would be influencing the height that it would be difficult to determine what might be the cause of creating a difference of even half a foot.

We know, though, that if the supply be reduced the surface of the water must necessarily be lowered. The difference caused by the Chicago Drainage Canal by itself may possibly be regarded as inappreciable, but when taken in conjunction with the proposed dam in the Niagara River it would be well to give the matter more consideration, as the manner of regulating the water there will increase the supply when the river is high and decrease

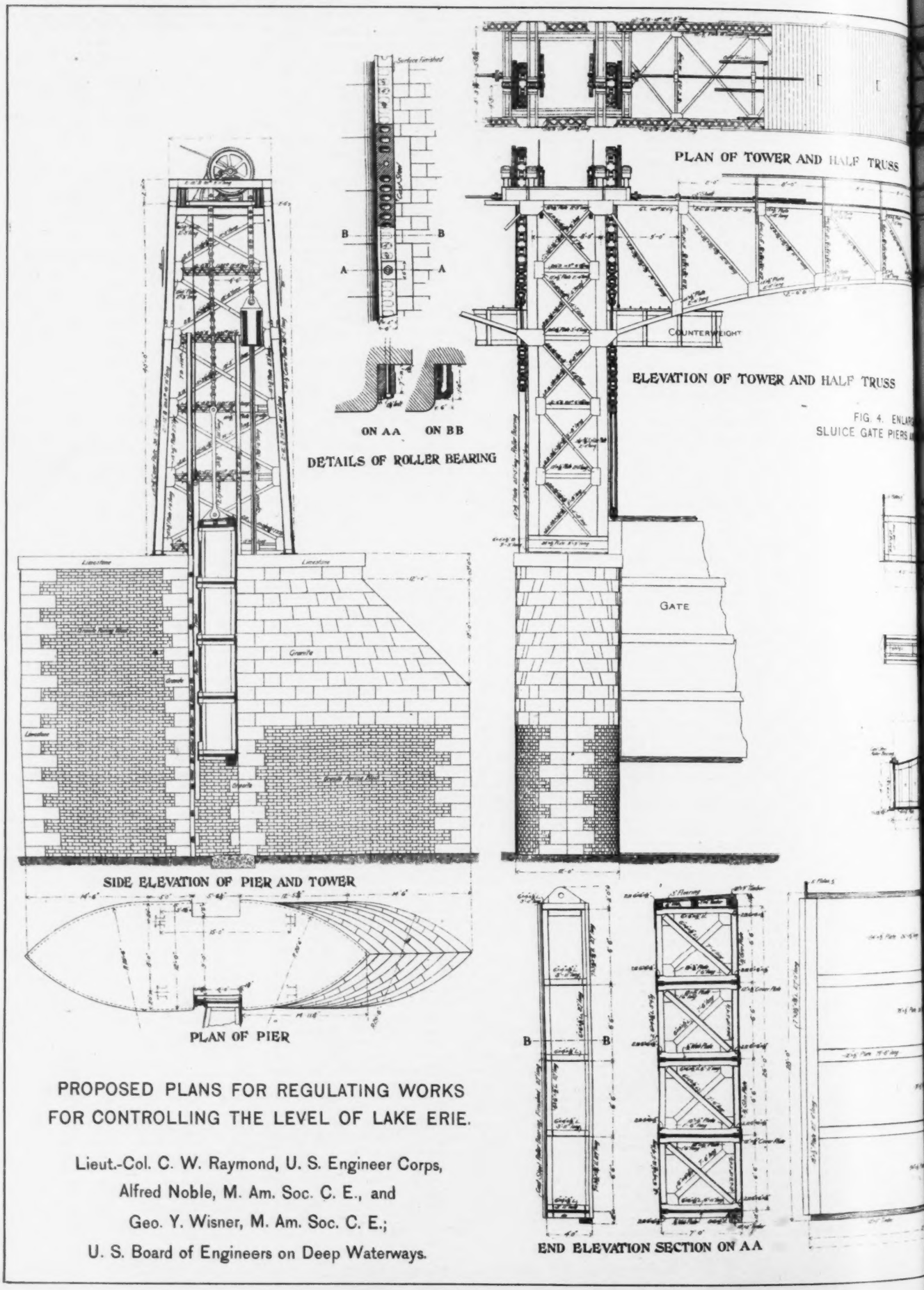
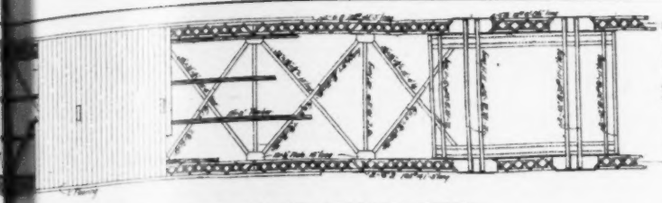


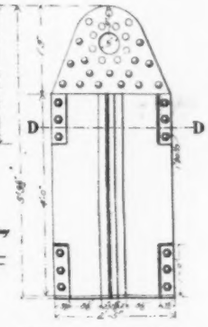
FIG. 4. ENLARGED DETAILS OF SUPERSTRUCTURE OF SLUICE GATE PIERS

PROPOSED PLANS FOR REGULATING WORKS FOR CONTROLLING THE LEVEL OF LAKE ERIE.

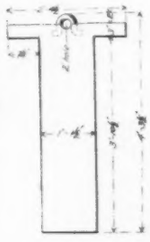
Lieut.-Col. C. W. Raymond, U. S. Engineer Corps,
Alfred Noble, M. Am. Soc. C. E., and
Geo. Y. Wisner, M. Am. Soc. C. E.;
U. S. Board of Engineers on Deep Waterways.



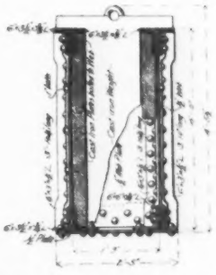
PLAN OF CANTILEVER ARM AND TOWER



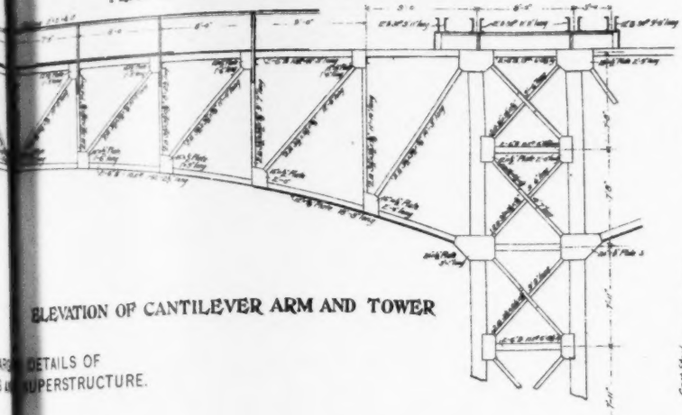
END ELEVATION



CAST IRON WEIGHT

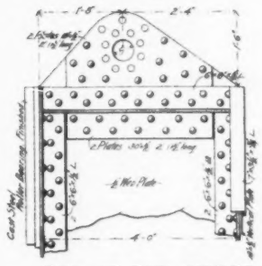


ENLARGED SECTION ON C C

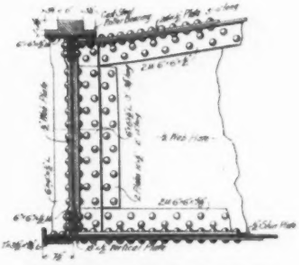


ELEVATION OF CANTILEVER ARM AND TOWER

FIG. 4. ENLARGED DETAILS OF GATE PIERS AND SUPERSTRUCTURE.



TOP OF END GIRDER



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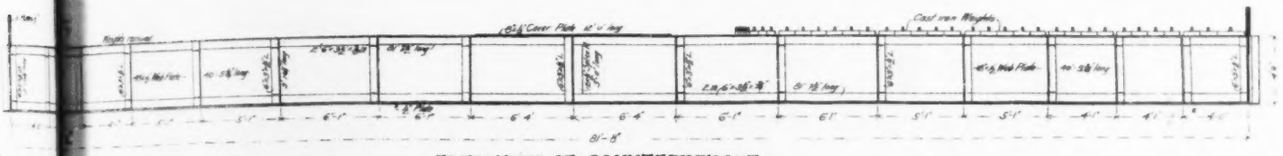
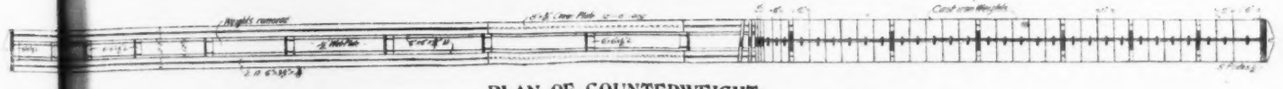
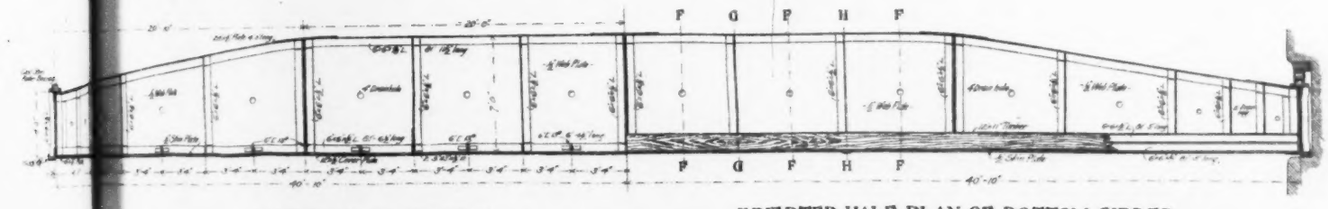


ELEVATION OF COUNTERWEIGHT

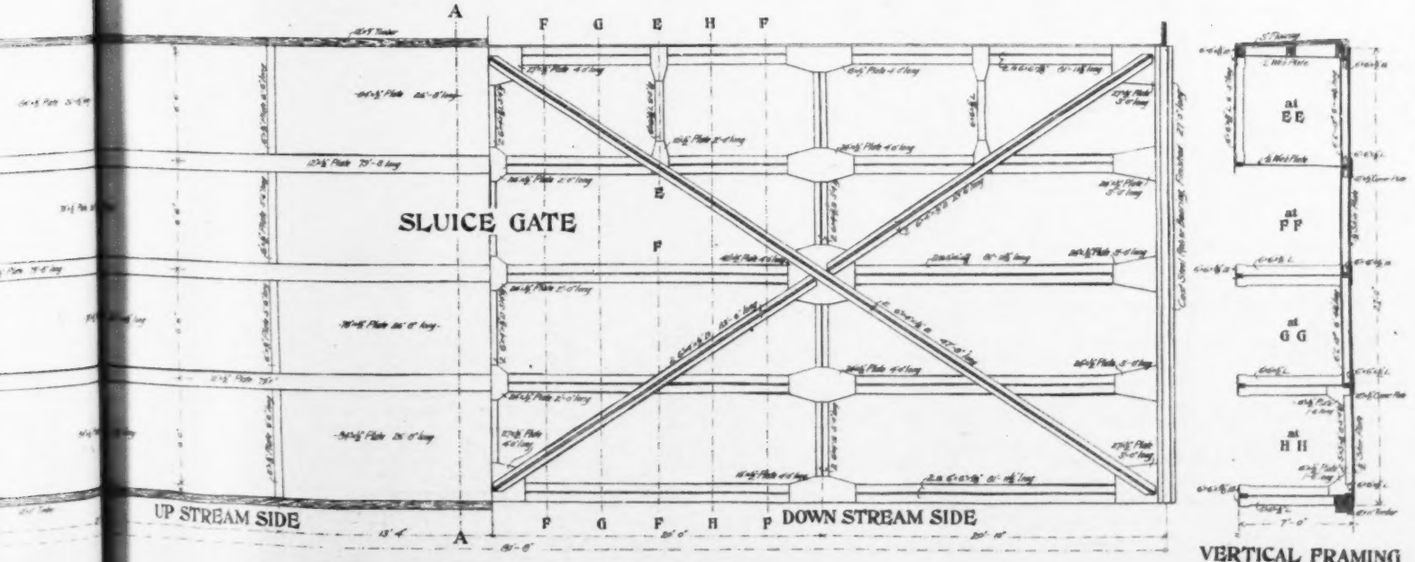


PLAN OF COUNTERWEIGHT



HALF PLAN OF GIRDERS

INVERTED HALF PLAN OF BOTTOM GIRDER



VERTICAL FRAMING

FIG. 5. DETAILS OF GATE LEAF AND COUNTERWEIGHTS

CHAS. HART, LITH., 86 VESEY ST. N. Y.

it when the river is low, thus tending to increase the difficulties in connection with the River St. Lawrence.

Possibly the place best suited for an examination of the probable effect is the reach from Cornwall to Valleyfield, known as Lake St. Francis. At the lower end of this reach the mean depth may be taken at about 15 ft. during low water, the fall in the reach at about 0.6 ft. and the discharge at 270,000 cu. ft. per second.

By the Chicago Drainage Canal the amount of reduction in the discharge will be 5,000 cu. ft. per second, and by the dam at the Niagara River 5% of 220,000 cu. ft. per second, making a total of 16,000 cu. ft. per second, which would be very nearly equal to 6% of the low water discharge at Lake St. Francis.

Now considering the extreme cases: (1) That the velocity remains the same; then the area of discharge must be 6% less, and so the mean depth would be 6% less = 6% of 15 ft. = 0.9 ft.; (2) that the area of discharge remains the same; then the fall in the reach must be decreased to lessen the velocity. Taking v_1 for the velocity at low water and v_2 the velocity for the reduced discharge and $v_1 = c_1 \sqrt{r_1 s_1}$ and $v_2 = c_2 \sqrt{r_2 s_2}$ the formulas for the velocities. Then

$$v_2 = 94\%\ v_1 = .94 \times c_1 \sqrt{r_1 s_1} = c_1 \sqrt{r_1 (.94)^2 s_1};$$

r_2 has been taken as equal to r_1 and c_2 will not be appreciably different from c_1

$$\therefore s_2 = (.94)^2 s_1 = .88 s_1.$$

The fall in the reach will practically vary directly with the hydraulic slope, therefore the fall in the reach, for the reduced discharge, equals 0.88×0.6 ft. = 0.53 ft.—that is, the surface at Cornwall would be 0.07 ft. lower under these conditions.

What intermediate course the water will follow, I do not know, but I think there is at least a probability of the surface at Valleyfield being lowered 0.3 ft.—that is, ½ of the amount determined under the first condition considered. At Cornwall the amount of reduction would be about 0.05 ft. more than at Valleyfield, owing to the reduced hydraulic slope.

Under some conditions 0.35 ft. difference in the height of the river surface may not be worth considering, but, as in the lower lock of the Cornwall Canal, there is little enough water during the time of low water, a difference of 0.35 ft. means considerable.

Although the discharges of rivers cannot be accurately determined, yet if, before the regulating dam be built, a number of measurements be taken to determine the discharges of the St. Lawrence at some of the more important places and at different stages of the water, and at the same time record be kept of the changes of the water surface at a few important places besides the upper and lower ends of the St. Lawrence Canals, a table or diagram could be prepared showing the relation between the heights of the water and the rates of discharge from which it would be possible to arrive at a fair idea of the change likely to be produced by decreasing the discharge to the extent proposed. The plan of operating the proposed works might be modified to suit the conditions found.

Yours truly, G. H. P.

Ottawa, Ont., Jan. 24, 1900.

Sir: Your criticism of the very timely and undoubtedly correct stand taken by the "Canadian Engineer" in its editorial on the St. Lawrence levels is no doubt very patriotic from your own standpoint, but it will need much stronger arguments than you have advanced to show that a reduction of about 10% of the low water flow of the Niagara will not affect the River St. Lawrence levels. The controlling works proposed at the foot of Lake Erie will undoubtedly be of great benefit to Lakes Erie, Huron and Michigan, and without question as far as these lakes are concerned, something of this nature should be built, but they should not be built without considering every side of the question. The commission in their report have apparently only dealt with one side of the question, namely that above Buffalo, and have neglected the fact that the people below any dam are generally in more danger than those above it.

Without going deeply into figures, it is well to point out that the Chicago Drainage Canal when discharging the 600,000 cu. ft. per minute for which it was designed, will reduce the low water flow of the Niagara River by over 5%, and as stated in your editorial in your issue of Jan 4, the proposed regulating works at Buffalo will for half the year decrease the flow by another 5% of the total annual discharge, or considerably over 5% of the low water flow.

Thus for half the year (and the low water half at that) the low water flow of the Niagara will be reduced by over 10%. It can readily be admitted that in high water years this would make no appreciable difference on the St. Lawrence, as far as navigation is concerned, but supposing these works had been in existence since 1894, what would have been the result? As it was, the navigation of the St. Lawrence was almost paralyzed, and had 10% of the flow in 1895 been withheld, there would have been no navigation at all.

You state that the percentage of flow deducted from the St. Lawrence will be considerably smaller than from the Niagara, as the St. Lawrence flow is larger than that of the Niagara by the entire run-off from the Lake Ontario watershed. Now, this is a very doubtful proposition, as the entire run-off from the Lake Ontario watershed in low-water years will, in the writer's opinion, not begin to make up for the evaporation. Of course, below Montreal the Ottawa River may reduce the percentage somewhat, but when it is remembered what an extremely small flow the Ottawa has at times it will be found that the reduction is very small.

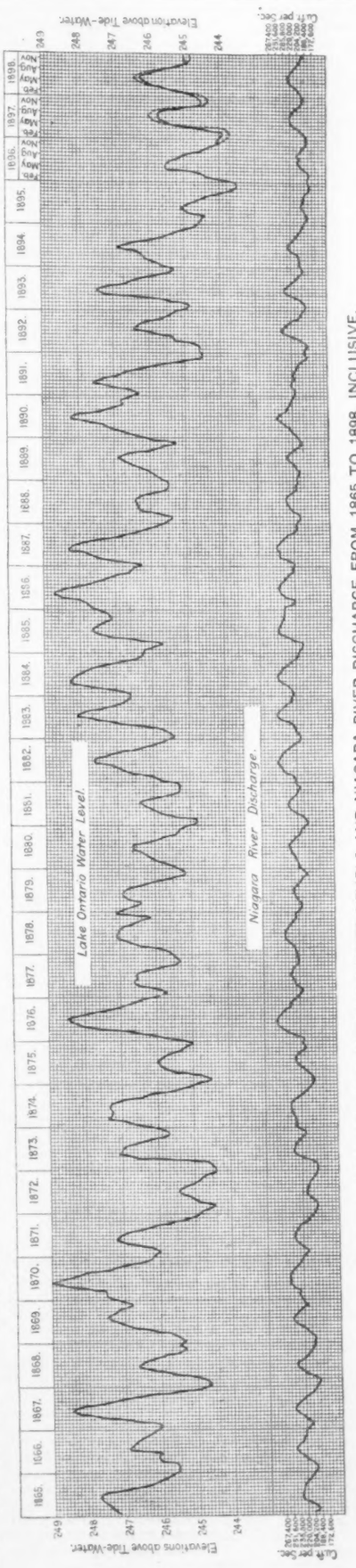
The Canadian Government has spent millions of dollars on its Canal System on the St. Lawrence, and has now numerous and expensive locks, with sills at a fixed level, which cannot be altered, so that where such schemes as the ones under discussion are proposed it behooves them to look thoroughly into the matter before giving consent to anything that might jeopardize their interests.

In view of your statement that "it is extremely doubtful whether the most accurate gagings will detect any difference of level in the St. Lawrence at Montreal as a result of these works," it would be interesting to know your idea as to just what amount of diversion and regulation on the upper lakes it would require to make an appreciable difference.

Yours truly,

J. L. Weller, Mem. Can. Soc. C. E.

Cornwall, Ont., Jan. 27, 1900.



CURVES SHOWING LAKE ONTARIO WATER LEVELS AND NIAGARA RIVER DISCHARGE FROM 1865 TO 1898, INCLUSIVE.

Note.—In the Niagara River discharge, 70,000 cu. ft. per second for one month, is equal to 1 ft. rise of lake.

In reviewing the discussions presented by our Canadian correspondents, the first thing to be pointed out is that there will be a very decided difference in the relative effect on Lake Ontario of the Chicago Drainage Canal, and of the proposed regulating works at the foot of Lake Erie. For instance, it is plain that the body of water which is discharged through the Chicago Drainage Canal, whether it is 5,000 cu. ft. per second or 10,000 cu. ft per second, is that amount of average annual loss to the volume of discharge through the lower lake waterways; and that if at any point on these waterways the increment of change of discharge for one foot change of stage is known, the average effect can be quite closely stated. For example, if the flow through the canal is 5,000 cu. ft. per second, and the increment of discharge for one foot change of stage of the St. Lawrence River is 30,000 cu. ft. per second for any given stage, the effect of the canal would be approximately 5,000 divided by 30,000, or about 2 ins. In fact, the amount of water which is withdrawn from Lake Michigan by the Drainage Canal is that amount of average annual loss to the volume of flow through the lower lake waterways, and must necessarily appear as a loss of stage.

The case is entirely different with the proposed regulating works at the foot of Lake Erie. These will not change the total volume of water annually flowing through the Niagara and St. Lawrence rivers, but will simply redistribute this flow during the different seasons of the year. If the result of these seasonal changes in the flow of the Niagara should be changes of the same proportion in the outflow of Lake Ontario, then the results obtained by our correspondent G. H. P., would be strictly correct. Lake Ontario, however, has a much greater range of stage than the other lakes, and, therefore, a much greater reservoir effect on the levels of the St. Lawrence River. This fact will be more fully brought out further on, and it furnishes a reasonable basis, we think, for our previous assertion, that while this proposed modification of the flow of the Niagara River must theoretically have some effect, the amount during the season of navigation will certainly be much less than the analyses given by G. H. P. would indicate.

It will readily appear from what has been said that the truth of the last preceding statement depends upon the accuracy of the assumption respecting Lake Ontario, which is that the rapid change in the volume of supply from its own watershed is the cause of the extreme fluctuation of its levels, and that the change of volume of the supply through the Niagara River has relatively very much less effect than that due to change of local supply and evaporation. In order to place this assumption on a foundation of facts scientifically verified, so far as was possible, we requested Mr. Geo. Y. Wisner, M. Am. Soc. C. E., who, as a member of the United States Deep Waterways Board, prepared the special report to Congress on the regulation of Lake Erie, to state briefly his observations respecting the probable change which would be produced in the levels of Lake Ontario by the proposed regulation of Lake

Erie. Mr. Wisner's reply to our request was as follows:

Sir: The elements which enter into this problem are constantly varying and necessarily approximate, but may be stated generally with sufficient accuracy to outline the changes which would be produced by regulation within reasonable limits. On page 17 of the report on "Regulation of Lake Erie" it is shown that the rapid changes in the level of Lake Erie are due to local causes (viz.: inflow from local watershed and evaporation), and not to change in supply through the Detroit River. The same characteristic is equally true of Lake Ontario. The rapid rise in the spring is due to the heavy sudden inflow from the relatively large watershed of Lake Ontario, and the equally rapid fall in the latter part of season is due to evaporation, at a time when discharge equals or exceeds the supply to the lake.

On page 18 of the report it is stated that the level of Lake Erie should be allowed to fall 0.6 ft. at the close of navigation each year, and, in years of high water, as much as one foot, which amount must be supplied by storage the following spring, and since the average storage in Lake Erie only amounts to 1.17 ft. (page 8) it will be noted that the storage effect of Lake Erie is really diminished only about 50 per cent.

While it is true that the report discusses the problem of controlling the level of Lake Erie near the elevation at which maximum supply and discharge are equal, it is very probable that Canada and Buffalo will insist on a lower plane of regulation being adopted than the one given in the report, which will simply mean that a minimum limit will be fixed below which the level will not be allowed to fall, and the level of lake will fluctuate between this limit and the high stage that would naturally be reached on any given year, or partial instead of complete regulation will very likely be adopted. It should be noted that with Lake Erie regulated, the discharge of the St. Clair River will be less in winter than at present and greater in July and August, which will compensate for a portion of the loss of storage in Lake Erie.

The increment of change in the discharge of the Niagara River is 20,000 cu. ft. per second for 1 ft. change of level at low stage of Lake Erie, and 30,000 cu. ft. per second for high water, and, from the best data obtainable, the increment for the St. Lawrence River is approximately the same. The effect on the level of Lake Ontario from increasing the discharge of the Niagara River may be expressed generally by the following equation:

Area of Lake Erie × depth of storage withdrawn = area Lake Ontario × rise from increased supply + increment for St. Lawrence River × ½ rise × duration of rise in seconds.

From the table on page 15 of the report it will be seen that in 1897 Lake Erie rose 1.55 ft. in five months, and in 1898 1.22 ft. in the same length of time. Allowing 0.6 ft. storage in Lake Erie and substituting the areas of the lakes in the equation, there results, for 1897, probable rise of Lake Ontario = 0.6 ft.; for 1898, probable rise of Lake Ontario = 0.4 ft.

These quantities represent the total rise during the season from low to high stage arising from increased supply through the Niagara River due to regulation, and, since the level of the lake will be below natural stage during the winter and above that stage during season of navigation, the variation from natural stage in 1897 would likely have been less than 0.3 ft. and for 1898 less than 0.2 ft.

The curve of change has been traced on the accompanying diagram for 1897 and 1898, from which it will be seen that the lake would have been from 0.2 ft. to 0.3 ft. higher during the summer, and the natural low water stage would have been practically maintained throughout the season of navigation.

If necessary for the preservation of the natural depth of the St. Lawrence channels a portion of the Lake Erie storage can be utilized for increasing the supply to Lake Ontario near the close of each season, and thereby absolutely maintain at least the natural stage until the close of navigation each year.

In 1870, the year of maximum stage in Lake Ontario, the storage in Lake Erie was only 0.8 ft., and, if the regulating works had been in place, the high water stage of Lake Ontario would have been raised only 0.1 ft.

It will be observed that Mr. Wisner's calculations indicate, as the probable result of the regulating works, that Lake Ontario will have its extreme high water stage increased from 0.2 ft. to 0.3 ft., and its extreme low water stage decreased about the same amount. These probable changes are best studied on the accompanying diagram. The important question, of course, is: what is the practical effect of these changes likely to be on navigation? Referring to the diagram it will be seen that extreme low water on Lake Ontario occurs on average years during the months of October, November and December. According to the best records the season of practical navigation on the St. Lawrence waterways is for average years from April 25 to Dec. 5. Evidently, then, the only time at which the effect of the regulating works is to be feared is during the months of October and November, and unfortunately this is the period of greatest navigation. These, then, are the conditions of the case as nearly as they can well be stated, and it is important to notice that even if they are thought to be damaging to the St. Lawrence navigation interests this damage is not irreparable.

It is quite possible to counteract at a comparatively small expense any probable decrease in the low water levels of October and November on Lake Ontario in at least two ways. The first of these is the one mentioned by Mr. Wisner in his letter printed above, which is to utilize a portion of the Lake Erie storage to increase the supply of Lake Ontario. A still more promising plan in many respects is to regulate the level of Lake Ontario itself by constructing regulating works at the head of the Galop Rapids in the St. Lawrence River. This plan is briefly referred to in the printed report of the Deep Waterways Board on lake regulation, as follows:

If it should be found desirable to control the discharge of the St. Lawrence River within such limits as to reduce the fluctuations of 5.5 ft. on Lake Ontario, under present conditions, to one-half that amount or less, it can be easily and cheaply accomplished by regulating works at the head of the Galop Rapids. The St. Lawrence River above the Galop Rapids is of large cross-section and has nearly the same slope for all stages of the river. At the head of Galop Island the river separates into two main channels with heavy rapids in each. The channel on the north side of the river can be enlarged at the head of the rapids and provided with regulating works which would greatly reduce the annual fluctuation of the lake levels. The physical features and conditions at this locality are discussed in report on the St. Lawrence River surveys.

A little study will show that, as a commercial proposition, the regulation of Lake Ontario as it has been proposed to regulate Lake Erie, is a matter which well deserves consideration. The fact which we wish to point out particularly at present, however, is that it furnishes a ready means for counteracting any damage which is likely to be done to the St. Lawrence waterways by a dam at the foot of Lake Erie.

The foregoing discussion has necessarily been brief, but it presents the facts somewhat more fully than has been done previously on which American engineers have based their claims for the co-operation of the Canadian Government in the project to regulate Lake Erie. The benefit which the navigation interests of the upper lakes will derive from regulation were fully discussed in out issue of Jan. 4, 1900, and they have not been disputed by Canadian shippers so far as we know. This makes the reason all the more pressing why the engineers of both countries should try to arrive at an agreement respecting the Lake Ontario and St. Lawrence River waterways. The bill now in Congress authorizes the U. S. Government to request the Canadian Government to co-operate with it in the appointment of a joint international commission to consider the whole question of lake regulation, and to report some feasible plan for bringing it about. It is not probable that our neighbor across the border will refuse to meet so fair a proposition half-way, and we may quite confidently assume that such a commission will be at work within a reasonable time.

LETTERS TO THE EDITOR.

Canal Traffic; Early Prophecies and Their Fulfillment

Sir: In the report of the Morris Canal & Banking Co. for the year 1835 is a paragraph which may be of some interest at the present moment. It refers to that part of the canal between Newark and Jersey City, which was nearing completion at that time:

It is difficult to put a value on the effects of this last link in a chain of canal communication commencing directly at the city of New York and extending into the very heart of our boundless interior, whose inexhaustible treasures are only waiting these avenues to be poured into the lap of the mistress of American commerce.

To any one familiar with the present condition of "this last link" and its traffic this sentence will seem somewhat ludicrous. It is strangely like some of the prophecies of the present day. Apparently there was no commission at that time to make recommendations as to the future of "our canals" and no commission to investigate the decline of New York's commerce or get excited over the railroads. Yours truly, H. F.

Brooklyn, March 9, 1900.

The Failure of a Railway Bridge Girder at Pittsburg, Pa.

Sir: In regard to the failure of the 60-ft. steel girder over Robinson St., Allegheny, Pa., on the line of the Pittsburg, Fort Wayne & Chicago R. R., mentioned in your issue of March 15, the following may be of interest:

The girder broke through the rivet holes of a web splice and without any visible tearing in any direction except along the line of rivets; that is, the top flange, bottom flange and web are broken nearly on a straight line and at right angles to the length of the girder. The bottom flange had the appearance of having been cracked for some time, as part of the fractured surface seemed to be rusty. The cover plate is wide and thin and the stiffeners are turned out at the ends to support it.

The girders are very old. This is one of the bridges to be replaced in the course of the track elevation in connection with the new Pennsylvania R. R. station in Pittsburg. Engineer.

Pittsburg, Pa.

Making Railway Embankments by Filling Trestles.

Sir: The inquiry made by "J. W. S." in your last issue about timber in railway embankments introduces a question that has caused engineers great anxiety. In all earthwork, whether thrown up in new construction or filled into trestle work as a road becomes better established and able to make improvements, it is almost a requirement that embankments be homogeneous and of such a character as to settle uniformly, for settle they must and will. Whatever interferes with this condition should, as far as possible, be avoided. Trestle work, whether of pile or of framed construction, is liable to interfere with such uniform settlement, even if considerably below the level of the roadbed. It may help to bind or hold together the central part of the embankment, which is usually firmer than the slopes, and then, after a long time, and when it might least be expected, as upon abatement of high water, a considerable portion of the embankment may move as one piece or body, not very far, of course, but enough to cause danger. Upon a curve this is especially liable to happen, and for evident reasons.

The bents in trestle work, whether of timber or piling, are not very far apart in the direction of the roadbed, while the breadth of the bents, extended by bracing or spur shores, is often much greater. If the bents are well tied together by bracing, or if piles are yet firm in position when the fill is made, either may act as a variety of retaining wall; and upon yielding after decay has proceeded far enough, a portion of the embankment less firmly supported near the base than it had previously been is liable to move out and cause trouble. In some cases it might be well to see that sway bracing was removed and other parts left in such condition that they would act as nearly as possible like free or independent members.

The inquest upon a very serious accident a number of years ago showed that the gradual decay of timber cribwork in the bottom of a deep fill had thrown a passenger train into the river, although the embankment at that point had been heavily reinforced, riprapped and regarded as perfectly safe for more than twenty years. No hard and fast rule can be established. The engineer must use his judgment in each separate instance. He should be certain not to sacrifice safety to mistaken views of economy, and he should be careful not to insist upon needless expense. M. Am. Soc. C. E.

New York, March 20, 1900.

What is the Value of Pressure in a Water Supply?

Sir: I notice in Engineering News of March 8, page 153, that the $70 per million gallons price offered by the Ramapo Water Co. is compared with the price of $35.62 per million gallons of the present supply. Don't you think that pressure constitutes a value in a water supply? And do you think it fair to compare a water supply to be delivered at 300 ft. pressure above tide at the city line, with one that has only 100 ft. pressure in the distribution reservoirs?

The fact is that pressure costs money, and must be charged for. It is pressure that is charged for in the case of hydrant rentals, and not water, as I could go on to illustrate, but have no doubt said enough to call your attention to the error (reflecting on the accuracy of Engineering News) on the page referred to.

Yours very truly, H.

New York, N. Y., March 8, 1900.

(Undoubtedly pressure has a certain value in a water supply; but when a great city has its entire distribution system adapted to a certain pressure, that pressure cannot be materially increased without trouble resulting. In the case of New York, if a head of 300 ft. were to be brought upon the distribution system, a large proportion of the street main distribution system and practically all the house plumbing would have to be renewed. The cost of this work would amount to a sum beside which even the huge demands of the Ramapo company would fade into insignificance. Be-

sides the actual cost, the nuisance of any such widespread tearing up of streets and wholesale renewal of plumbing fixtures in residences, stores, offices, factories, and buildings of every class would not be tolerated even by the long-suffering residents of New York. Any city government which should attempt to carry out such a work would be swept out of existence.

Again, what would our correspondent do with the city's present reservoir system if he decided to turn the 300-ft. pressure directly into the city's distribution system? He surely would not undertake so radical an experiment as to supply this great city by direct pressure, without storage. Moreover, the Croton supply must come in at a much lower pressure anyway! The proposition to raise the pressure on the entire distribution system, therefore, is absurd from every point of view.

We presume our correspondent will say, however, that this water at 300 ft. head would not be turned into the main distribution system, but would be used to feed a special system of mains for fire protection. It would not be proposed, of course, to lay a duplicate system of mains through the streets generally, but it might be, and in fact has been, proposed to lay special mains from the point where the Ramapo supply is proposed to be delivered down to the wholesale mercantile and office building district of lower New York, where, it has been claimed, the present supply might prove insufficient to check a conflagration.

It must be remembered, however, that this district is nearly 15 miles from the northern boundary of the city, whereas it is only about five miles from the Central Park reservoirs. What is needed in this district is quantity of water rather than greater static pressure; and we are inclined to the belief that better results, in the increase of quantity and available pressure, could be secured for a given cost by laying additional mains from the Central Park reservoir to this district rather than by laying such high-pressure mains as proposed from a point three times as far away.

We believe, therefore, that a 300-ft. water supply would be practically worth very little more to New York than the same supply delivered under the same head as the Croton. Its chief usefulness would be in supplying some small areas of the city located on such high ground that the supply from the present distributing reservoirs has to be raised by pumping.

Let us, however, for the sake of argument, adopt our correspondent's apparent view, that the city needs and wants the whole Ramapo supply at the 300-ft. head. How much more can it afford to pay for it per million gallons than if it were delivered at a head of 100 ft?

The answer to this question is, it seems to us, perfectly simple. It can afford to pay as a maximum the cost of the power necessary to raise the supply to the 300-ft. pressure. One million gallons of water weighs 8,340,000 lbs., and to raise it to a height of 200 ft., or force it into mains against an equivalent pressure, would require 1,668,000,000 ft. lbs. Dividing this quantity by the number of foot-pounds developed by an engine of one horse-power working continuously for 24 hours, we find that between 34 and 35 horse-power days is the equivalent of a million gallons of water raised 200 ft. The cost of continuous power per horse-power per annum under the conditions existing in New York may be fairly assumed at $40 per annum. (See papers of the late Dr. C. E. Emery before the American Institute of Electrical Engineers.) Assuming 340 working days in the year, this brings the cost of the power for 34 days to $4.

As a check on the above figures, reference may be made to the paper of Mr. Samuel Artingstall before the American Water-Works Association some years ago, in which the actual entire cost of pumping water in several of the principal cities of the United States was summarized. These figures showed a cost per million gallons raised 200 ft. high of $4 to $7. If, then, New York wanted a 300-ft. head water supply, it ought not to pay more than this amount in excess of the cost of a similar supply at a head one-third as great. We contend, however, that it has no use for such a supply. Where increased pressure is desired to supply elevated districts or for special fire protection purposes, it can be furnished by properly-located pumping engines far more cheaply than by piping a gravity supply from some far distant source.—Ed.)

RELINING A TIMBER-LINED TUNNEL WITH BRICK MASONRY; NORFOLK & WESTERN RY.

The original construction of many American railway tunnels with a timber lining to reduce the cost and to hasten the work has made it necessary to reline them as time has passed with some more permanent material. In most cases the work of removing the old lining and replacing it with the new masonry has had to be done without interfering with the running of trains, and a number of ingenious methods have been developed by engineers for accomplishing this task. One of these methods, which was adopted in relining the 6,112-ft. Boulder Tunnel on the Montana Central Ry., was described in our issue of Oct. 12, 1893, and we illustrate another and a different method which is now being employed in relining 1,410 ft. of a single track tunnel located between Virginia City and Coeburn, Va., on the Clinch Valley Division of the Norfolk & Western Ry. The work is being done under the direction of Mr. Charles S. Churchill, M. Am. Soc. C. E., Engineer Maintenance of Way.

The tunnel referred to has a total length of 1,902 ft., but only 1,410 ft. of it were originally lined with timber. This old timber lining consists of bents spaced 3 ft. apart and located as shown by the dotted lines in the cross-section, Fig. 1. Instead of renewing this timber, it was decided to replace it with a brick lining. Although the tunnel was constructed through rock, this rock is of a seamy character, and in some portions of the tunnel it disintegrates on exposure to the air. In removing the timber to make place for the new lining some of the roof is found close to the lagging, but often also considerable sections show breakages in the roof extending to a height varying from 1 ft. to 12 ft. above the upper side of the timbering. This dangerous condition of the roof made it necessary that only a small section of the timber lining should be removed at one time. It made it necessary, also, that the brick arch should be built quickly to close this opening, and finally that all details of centers, etc., should be arranged so as to furnish ample clearance to trains. The accompanying illustrations show the solution of the problem which was arrived at.

Referring to the transverse and longitudinal sections shown by Fig. 1, it will be seen that two side trestles were built to carry an adjustable centering for the roof arch. Two sections of these trestles and centerings were used alternately, one being carried ahead and set up to remove the timbering while the masons were at work on the other. The manner of setting up and adjusting the trestles and centerings is shown by Fig. 1 and also by Fig. 2, which is an enlarged detail drawing of the set screw and rollers for the centering ribs. The following is the bill of material required for one set of trestles and one center:

Trestles:						
Caps and sills	8	pieces	8 ×	8 ins. ×	20 ft.
Posts	18	"	8 ×	8 " ×	11 "
Braces	16	"	6 ×	4 " ×	7 "

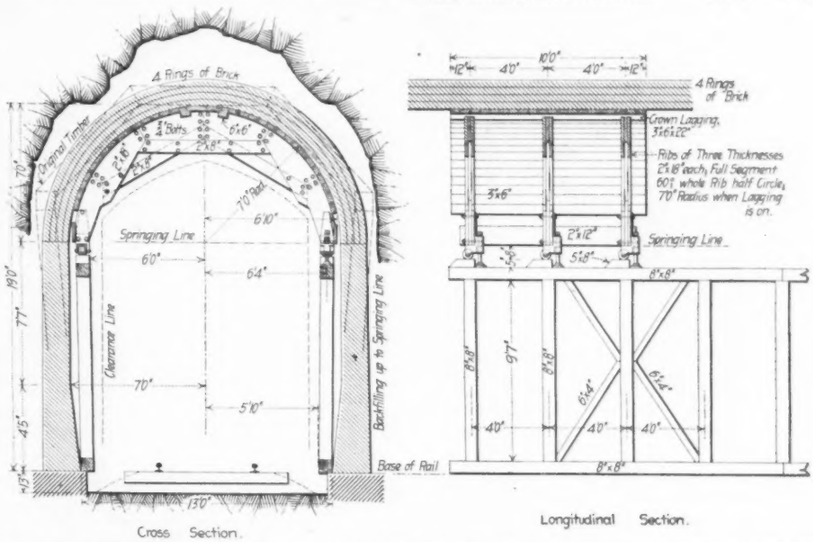

4 Rings of Brick
Diagonal Timber
1" Bolts
Springing Line
Centre Line
Batter of Masonry to Springing Line
Base of Rail
Cross Section.
4 Rings of Brick
Crown Lagging, 3"x6"x22"
Ribs of Three Thicknesses 2"x8" each, Full Segment 60°, whole Rib half Circle, 70" Radius when Lagging is on.
Springing Line
Longitudinal Section.

FIG. 1.—SECTIONAL ELEVATIONS, SHOWING ADJUSTABLE CENTERING USED IN RELINING A TIMBER-LINED TUNNEL WITH BRICK MASONRY; NORFOLK & WESTERN RY.
Chas. S. Churchill, M. Am. Soc. C. E., Engineer Maintenance of Way.

Centerings:						
Ribs	27	pieces	2 ×	18 ins. ×	7 ft.
Bracing	12	"	2 ×	8 " ×	7 "
Support to crown lagging	2	"	6 ×	6 " ×	10 "
Crown lagging	20	"	3 ×	6 " ×	2 "
Side lagging	30	"	3 ×	6 " ×	10 "
Side strips	2	"	2 ×	12 " ×	9 "
Blocking for rollers	1	"	5 ×	8 " ×	12 "

6 screw and roller castings complete with bolts and lever; 114 bolts ¾-in. in diameter; 7½-in. U. H. hexagonal nut and 2 cast washers each.

With this arrangement the progress made per day varies from 2 lin. ft. to 3 lin. ft. of lining complete. By work complete is meant the entire lining, including stone packing between the brickwork and the rock. On Feb. 23, 363 ft. of lining had been completed, at a cost of $33.50 per lin. ft. This cost includes the cost of removing the old timber, the loose rock above it and all other

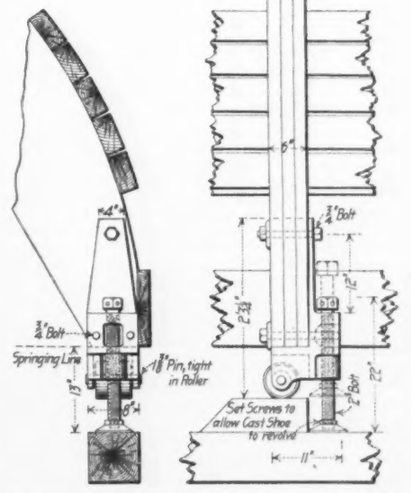


Fig. 2.—Enlarged Details of Set Screws and Rollers for Adjustable Tunnel Centering.

work of whatever character, the entire work being done in such a manner as not to interfere with traffic. We are indebted to Mr. Chas. S. Churchill, M. Am. Soc. C. E., Engineer Maintenance of Way, Norfolk & Western Ry., Roanoke, Va., for the information from which this description has been prepared.

A NAVAL GENERAL STAFF, with Admiral Dewey at its head, has been appointed by Secretary of the Navy Long. Under General Order No. 544, the Admiral of the Navy, Chief of the Bureau of Navigation, Chief Intelligence Officer and his principal assistant, the President of the Naval War College and three other officers above the grade of Lieutenant-Commander, compose the general board. The purpose of this board is to insure efficient preparation of the fleet in case of war and for the naval defences of the coast; and to devise plans of campaign and war preparations. The chief value of such a board will be properly to digest measures proposed for the advancement of the Navy and to present them in proper form for action by the legislative part of the government. Under existing methods requests for legislation are often placed before Congress in such crude form that results are not satisfactory in their operations to the very persons who have asked for them.

THE ENGLISH NAVAL ESTIMATES, for 1900-1901, amount to $137,613,000; in which an increase of $4,640,500 provides for 220 additional officers and 4,020 men. In 1900, there will be under construction 17 battleships, 20 armored cruisers, one first-class protected cruiser, two second-class protected cruisers, one third-class cruiser, eight sloops, two gunboats, four torpedo boats and 21 destroyers.

A MAUSER AUTOMATIC PISTOL is made at Oberndorf, Germany. The magazine holds 10 rounds fed from a clip. The caliber is .3004-in.; initial velocity of the 5.5-gramme projectile is 1,394 ft. sec.; with a penetration of 10.6 ins. of pine at 32 ft., 4.7 ins. at 50 ft., and an extreme range of 3,280 ft.; the ball will break bones at 984 ft. The action is automatic; the recoil of the barrel operating the mechanism; though it can also be used as a single-fire.

GERMAN MANUAL TRAINING SCHOOLS now number 861, says U. S. Consul George Sauter, of Glauchau. Of these 836 conduct the training on a pedagogical basis, and 1,514 workshops are connected with the 861 schools. Of the latter 531 are devoted to wood carving and 527 to working in cardboard. The tuition is of three kinds; that regarding handicraft as a means to general culture; the so-called school-manual dexterity method, and the system which makes manual training the basis of individual branches of teaching.

TO SAVE THE PALISADES, the State Geologist of New Jersey, Mr. J. C. Smock, proposes that an interstate commission fix a line near the foot of the cliffs, beyond which no commercial, mining, shipping or industrial scheme shall advance landward. He believes that by such action the cliffs themselves can be preserved; and the income to the New Jersey schools from grants of riparian lands would still be preserved. He argues that buildings and factory chimneys at the base of the cliffs would not interfere with their scenic beauty.

MOTOR-VEHICLES WERE TESTED ON SNOW-COVERED roads last week by two members of the Automobile Club. One used a light Winton road motor operated by gasoline, and made the run of 24 miles, between the Waldorf Hotel and the Ardsley Clubhouse, in 1 h. 55 m. The other member of the club made the trip in a "locomobile," operated by steam, and consumed 40 minutes more on the trip. The road was partially covered with snow and ice and was very heavy in some parts.

THE IMPROVEMENT OF THE CHICAGO RIVER, as forming practically a part of the Chicago Drainage Canal, will be undertaken by the Drainage Board. A proposition has been made to the city by the Board, and is generally approved by the authorities, under which the Drainage Board will assume control of the main channel and south branch of the river, and will undertake to improve it for navigation by removing the center piers of bridges, building new bascule bridges, cutting of corners and encroachments, and establishing a service of patrol boats to direct and assist in the handling of large vessels in the current caused by the opening of the canal. Heretofore the river has been practically a stagnant stream, and the difficulties now arising from attempts to handle vessels in the current by inefficient means has led to some excitement in shipping circles. It has even been declared that the river is insufficient to supply the necessary amount of water to the canal without causing an unsafe current, and that a new canal must be cut across the city to the lake. The Drainage Board, however, has pointed out that it is yet entirely too soon to make any such statements, as the river has yet to be improved and the handling of vessels in streams having swift currents is a matter of everyday occurrence. More powerful tugs and greater skill may be required for the larger vessels.

BOOK REVIEWS.

THE COST OF LIVING AS MODIFIED BY SANITARY SCIENCE.—By Ellen H. Richards, Instructor in Sanitary Chemistry in the Massachusetts Institute of Technology. New York: John Wiley & Sons. London: Chapman & Hall. Cloth; 5 x 7 ins.; pp. 118. $1.

This is a suggestive volume written by one who has been known for many years for her work in sanitary chemistry, domestic economy and other lines of scientific progress. The author deplores the fact that the same scientific and business-like methods are not employed in household as in industrial establishments. Many practical hints are given regarding healthful homes, food and clothing and the apportionment of expenses so as to leave at least a little money for books, music and other forms of literature and art, travel and the "higher life" generally. The use of the word "sanitary" in the title seems to be rather a broad one, in view of the fact that the discussion involves almost as much of economic as of sanitary science.

REPORTS ON RAILWAY ENGINEERING AND MAINTENANCE OF WAY.

At the first annual meeting of the American Railway Engineering and Maintenance of Way Association, a report of which is given in another column, the 14 standing committees were all heard from, and several of them gave quite full and valuable reports. The following are abstracts of several of these reports:

Yards and Terminals.

The problems involved in the yards and terminals of a railway stand in intimate relationship to the operation of the line, and a careful adjustment to the traffic requirements, immediate and prospective, is essential to the development of the ultimate capacity of the property.

It will be the function of this committee to ascertain by investigation the conditions which are common upon all lines, and to determine principles involved, to the end that there may be established a practice that shall meet with general approval and be recognized as standard.

Comparatively few railways are in a position to consider questions arising in connection with terminal work, free from the limitations imposed by the existence of facilities already established. In many cases the traffic conditions have so changed that the existing arrangements are inadequate to present requirements and an entirely new plan is needed, while in others an enlargement of existing facilities will serve all necessary purposes. It is not always an easy matter to determine which course is the wisest to pursue, and an investment in the expensive work usually involved in such improvements is apt to be of a permanent character, carrying with it benefits or disadvantages dependent largely upon the skill and judgment of the designing engineer.

It is believed that many errors of design in such work may be avoided by the elucidation of the principles which appertain to the different branches of terminal service.

A. W. Sullivan, Ill. Cent.; F. E. Paradis, Chicago Terminal Transfer; J. W. Thomas, Jr., N. C. & St. L.; I. G. Rawn, B. & O. S. W.; E. E. R. Tratman, Resident Editor Engineering News; R. B. Tweedy, Wis. Cent.; S. P. Hutchinson, Pennsylvania; J. B. Cox, Chicago Junction; C. W. Hotchkiss, Chicago Transfer & Clearin Co.; C. S. Sims, Jr., Pennsylvania; W. S. Kinnear, Mich. Cent.
Committee.

Grading.

Standard cross section for cuttings and embankments, like standards for other items of railway work, should be the outcome of the best theoretical knowledge, coupled with experience acquired from extensive and varid practice.

After arriving at a decision on the best form of roadbed under ordinary circumstances, for the respective classes of material with which embankments are constructed, or through which the railroad passes in cuttings, consideration will be given by this committee to other questions; the relationship of the angle of repose of any given material to height (whether or not it is constant), the actual angle of repose most suitable for the various kinds of material; the greater capacity of roadbed ditches for deep cuttings, on account of the greater quantity of surface water shed by these slopes; the capacity of roadbed ditches increasing toward their outlet in cuttings of extensive length, through which the track may be level; troublesome pockets of quicksand which may occur, and for considerable extent; and how far, in northern latitudes, the matter of snow in cuttings unprotected by coverings affects the contour of the standard, for there are instances of "bad spots" in certain cuttings, where atmospheric and other local conditions produce drifts not altogether preventable by snow fences.

Sodding and seeding and the planting of willows will also receive attention.

When building a railroad, it is often the case that really good material from cuts is wasted, in order to save haul, whereas, at reasonably additional first cost, it might in many instances be saved, and dumped over embankments to a sufficient depth to allow the quick formation of a good sod from seeding, which would not wither up during drouths.

The question of what is the steepest grade or sharpest curve for economical operation cannot be answered without reckoning on the immediate physical conditions of the road in proximity to each particular ruling condition, and in this the committee expects to make investigations into train resistance generally, due to grades and curves, and the actual cost of overcoming this resistance in actual practice. Consideration will be given to the features in which a new location may be preferable to improving the present one; also to cases where the reduction of grade and curvature involve a certain amount of new location. The introduction of vertical curves at changes of grade will also be considered.

J. B. Berry, Union Pacific; W. McNab, Grand Trunk; J. A. Atwood, P. & L. E.; R. C. Barnard, P., C. C. & St. L.; G. M. Brown, F. & P. M.; H. Baldwin, C., C., C. & St. L.; C. Dougherty, I. C.

Water Service.

This subject has been outlined under three general heads: (1) Source of supply; (2) Method of pumping and supply; (3) Character of water.

(1) The source of supply is a comparatively simple question when the character of the country is such that there is abundance of water to be had, and the only things to be considered in such favored localities are, the selection of the water best adapted to boiler use, and the cheapest method of obtaining it.

In some portions of the arid districts of the West and Southwest the question of obtaining suitable water at any cost is a difficult problem. In other portions there is water to be had at a reasonable cost, if one has the good fortune to find it; but in the search for it the element of chance sometimes enters more largely than engineering skill. The work of the committee under this division of the subject, should be largely devoted to obtaining all of the information possible with regard to the location of underground water and its relations to different soils and different strata.

(2) In selecting the location of water stations, the questions of convenience, minimum delay, safety of trains and economy should be considered. On very busy lines, facilities for taking water should be located at regular stations, while on lines where traffic is light it is sometimes advisable to locate tanks between stations, as a matter of economy; but whenever they are so located, the question of grades and of protection to trains should be considered.

Under the head of pumping, a thorough investigation of the circumstances where windmills can be used to advantage should be made, and, also, a complete investigation of the relative cost of the use of gasoline engines for pumping purposes as compared with steam pumps. A great many gasoline pumping plants have been established during the past few years, but owing to the rapid rise in the price of gasoline, some of them have been discontinued and pumping by steam substituted.

(3) As to the character of the water, we all know that water that the chemist pronounces totally unfit or very bad for boiler use is nevertheless used for the want of something better, and, in a way, serves its purpose in getting trains over the road, probably at a large expenditure for new flues and boiler repairs.

There are many instances where poor water is used because of the necessity of a large expenditure of money to obtain good water; but each case of that kind must be considered upon its merits, being merely a comparison of the saving in boiler repairs with the annual interest charge upon the amount necessary to be expended to obtain good water.

W. E. Dauchy, C. R. I. & P.; D. Willard, B. & O.; H. C. Draper, C. & A.; O. D. Richards, Ann Arbor; W. B. Story, Jr., S. F. & S. J. V.; G. H. Webster, M. & N. W.; Samuel Rockwell, L. S. & M. S.

Ties.

In all publications relating to either the preservation or use of ties, one is struck by the absence of accurate statistical data. Railway engineers and maintenance of way officers derive the greatest assistance from constant and close consideration of results attained on the lines of their neighbors and connections, as shown in statistics of operation. I would, therefore, most urgently recommend that blank forms be printed by the association and sent out to all members, with a request that at least some of the data called for be furnished if it be found impracticable to furnish all, believing that, after the first few years, the value of this information will be so patent and highly appreciated that little or no difficulty will be met with in procuring everything desired.

Together with this statistical statement I would suggest the rendition of other annual statements in the nature of progress reports showing what is being done in the way of preserving ties; what results have already been obtained from the various methods, and what has

been determined to be the average life of ties of various kinds of wood. Some of the subjects to be handled by the committee can be pretty well exhausted with one thorough investigation, while others are of lasting interest and should be studied over long periods of time, therefore requiring progress reports annually. In the first category we might place inspection, disposition of old ties, methods and general questions; while in the second category we might place the subjects of material, preservation and cost.

J. Kruttschnitt, So. Pac.; G. W. Kittredge, C., C., C. & St. L.; J. J. Frey, Topeka; W. L. Darling, Nor. Pac.; A. P. Herbert, M. N. C. Co., (Mex.); O. Chanute, Chicago; William Archer, B. & O. S. W.; W. C. Cushing, Pennsylvania.

In the discussion, Mr. E. E. Russell Tratman (Associate Editor, Engineering News), referred to the universal difficulty of keeping track of ties when once laid, and to the importance of using some method of marking, either by stamping hammers or nails. Mr. Kittredge (C.,C.,C. & St. L. Ry.) stated that the use of marking hammers was begun in 1892, but was not satisfactory and has been abandoned. Mr. Samuel Rockwell (L. S. & M. S. Ry.) and Mr. W. G. Curtis (So. Pac. Ry.), however, are both using hammers and find them satisfactory, though the latter preferred nails. The former uses a hammer of cast iron, with a raised figure for the last figure of the year. Mr. Wallace (Ill. Cent. R. R.) referred to the great importance of the tie question, and the great difficulty of obtaining reliable information. In regard to renewals, on his road the supervisors walk the track with the foremen and select the ties to be renewed. The number for each mile is shown on the statement sent to headquarters, and the roadmasters check the supervisors' judgment by walking over certain miles and examining the ties selected. The old ties are also piled and inspected after removal. He considered that the time is in sight when the scarcity and price of timber will necessitate the use of preservative processes in order to enable inferior wood to be used to advantage. And after that, the question of introducing metal ties will became important. Mr. O. Chanute spoke of the advantages of preservative processes. In France, beech ties are treated with 60 lbs. of creosote per tie, at a cost which would be prohibitive in this country, but the life of the ties is from 25 to 50 years. Mr. Tratman spoke of the progress made with metal ties in other countries, and Mr. Kittredge described his company's work in planting catalpa trees on waste land, old gravel pits, etc., where the land is unproductive but is subject to taxation (Eng. News, Dec. 14, 1899). The catalpa was selected on account of its quick growth and its value for ties and fence posts, but Mr. W. G. Curtis (So. Pac. Ry.) had not found these trees satisfactory on plantations in California.

Ballasting.

(1) Stone.—There exists a wide diversity in practice with regard to the size of broken rock ballast, although the tendency appears to be now in the direction of the smaller sizes.

(2) Gravel.—Gravel is perhaps the material most largely used for ballast. It is usually readily accessible, cheaply loaded, and with it track can be economically maintained. In considering the economic maintenance of track the character of the gravel will have to be taken into account. Whether it is cheaper to maintain track on cementing gravel, or on loose or sandy gravel. What is the effect of the sand on wear of rail? We might even carry the inquiry outside of the department interested in the maintenance of way, and ask what effect has the sand on the tires of rolling stock. This may seem, at first sight, a little far-fetched, yet the records of the Louisville & Nashville R. R., for the Mobile & Montgomery Division now show an average of 16,000 miles run to 1-16-in. wear of engine tires whereas formerly 9,000 miles was the average, and the Superintendent of Machinery attributes the difference to be due to slag ballast having been substituted for sandy gravel ballast.

(3) Burnt Clay.—It would seem that where a good natural ballast is readily accessible, an artificial article would not be advisable, and that the distance from nearest coalfield would enter largely into its cost.

(4) Slag.—The use of slag as ballast is growing in favor. In the South the "hot-pot" slag from the iron furnaces is of particularly good quality for this purpose. The slag is poured from hot pots, run on trucks to the dumping point; it spreads itself in thin layers, which renders it hard and brittle, easily broken to suitable size for ballast. The slag formerly made at these furnaces was of a porous, spongy character, hard to break to the proper size, and with a tendency to cement together again, hence it made poor ballast.

(5) Cinder.—Cinder is a waste product on all railways that run coal-burning engines. It is used by most of them as ballast, if not on their main lines, then in yards and for side tracks. Where the roadbed is soft, excellent results have been obtained from its use. It is claimed by some that cinder ballast is destructive to both the ties and rail.

(6) Chatts.—Chatts are the tailings from lead mills and are about the size of very coarse sand. The material is easy to tamp, making the renewal of ties cheap; heavy in weight, hence holding the tie in place; and comparatively free from dust.

(7) Earth.—Earth as ballast has been largely used in this country in the past, and few large railways can be found at the present time that have not some part of their lines ballasted with earth or "dirt," as it is often called.

(8) Chert.—Chert is also used to ballast branch lines in the South, and is infinitely better than ordinary dirt, though not the equal of rock, slag or the best character of gravel. It is excellent at road crossings.

(9) Dust Prevention.—Until recently no serious attempt was made to prevent dust rising from the ballast of track, except by permitting grass to grow over the track; for example, Bermuda grass in the South. Within the past few years oil has been used for this purpose, apparently with success. It is claimed not only to lay the dust, but also to prevent growth of weeds.

(10) Distribution.—Care should be exercised to avoid the loss of material in handling, particularly in plowing and spreading, or else much of the ballast is liable to go down the bank. The placing under the track is accomplished by means of jacks, shovels or ballast forks, and tamping bars or picks, in addition to which levels and lining bars are needed in surfacing and lining. It is desirable to learn the proportionate force usually employed at these different classes of work, which are all conducted at the same time.

R. Montfort, Louisville & Nashville; W. H. Peddle, Southern; A. Mordecai, Erie; J. R. Leightey, C. & N. W.; Edward Shelah, Wabash; J. T. Richards, Pennsylvania; H. U. Wallace, I. C.

In the discussion, Mr. W. C. Cushing (Pennsylvania Lines), referred to the use of screened gravel, which he is using experimentally on account of the sandy and dirty quality of the available material as it comes from the bank. An elevator and revolving screen are used and the cost of screening is about 20 cts. per cu. yd. The cost of handling gravel ballast, distributed on the roadbed is from 5 to 6 cts. per cu. yd. Mr. Rockwell (L. S. & M. S. Ry.) had made tests of his gravel and found that it contained 50% of sand and 50% of gravel varying from the size of a grain of wheat to that of an egg. Mr. McFarlin (D., L. & W. R. R.) and Mr. McGuigan (Grand Trunk Ry), gave particulars of the use and cost of burnt clay ballast, which is in the main a very satisfactory material. It does not heave, and it drains well. One cubic yard of clay will make 2 cu. yds. of ballast, and there will be required 1 ton of slack coal to 3 or 5 cu. yds. of ballast. The use of slag also came in for discussion.

Rails.

The expenditure on account of rail renewals based on figures for past five years would be about $14,000,000 per year. This does not represent the amount paid mills for new rails, as that amount is offset by amounts received from sale of scrap and old rail applied to construction of sidings, etc. It would appear fair to estimate that about $25,000,000 is paid out per year to the rail mills by our railways.

A glance over the maintenance of way and structures accounts indicates that expenditures on account of rails come second to ties, and taking into consideration the large amount involved, an increase of one year in the life of our rail means a considerable saving. On account of the sharp competition for traffic, low rates and the necessity of bringing down the transportation expenses to meet the constantly decreasing rates, the rail question may be considered to be one of prime importance.

It is a duty of the engineer to use such materials as shall be economical both in original cost and maintenance. The two items of original cost and maintenance are very closely related. If we now pay $33 for a rail lasting, say ten years, it is costing us $3.30 per year; if by paying $34 we could get a rail that would last eleven years, it would cost us $3.10 per year—a saving we could well afford to make. So we see that there is possibly no problem worthy of more attention than the one of economical wear and service of steel rails.

Many well meaning efforts at reform have been in vain on account of the very radical position taken by some of the persons connected therewith. Therefore, if any of us incline to extreme views in such matters as high carbon or low carbon, let us find at least some common ground on which we can take a stand and then we shall make headway, possibly slowly, but surely. If we agree on uniform sections for all our lines we will eventually save for our companies, and possibly, in addition increase the profits of the rail manufacturers, about which so much talk has been heard in Pittsburg recently. Let us agree on one other thing—that the mechanical treatment in rolling and the temperature at which the rail is finished is of the greatest importance—and then insist on the mills making an improvement in this regard.

If this association can agree on a specification for the manufacture of rail, which may not be perfect, but which will be a step in advance of what we are doing, have it approved by our companies, and accepted by the rail manufacturers, decided progress will have been accomplished.

The committee being of the opinion that the Am. Soc. C. E. sections are a step in advance, is of the opinion that no new sections should be suggested until we have had full time to learn from experience the merits of these sections. It is recommended that all members of this association whose lines are not using these sections be urged to have them adopted and used on their lines. The results should be carefully compared with results from the old sections. The best results from the Am. Soc. C. E. sections will not be obtained until better work is done at the mills, and this brings us to the chemical constituents and the mechanical treatment, the latter being probably the more important.

It is our opinion that the wearing quality of the rails will be improved by taking more time for the finishing passes at the rolls. This does not mean that the speed of the rail mill need be reduced, but that provision be made for holding a number of rails at a certain stage in the rolling, allowing them to come to a certain temperature, which will also mean that the heat retained in the rails will be distributed uniformly throughout. The rails are then taken in the order in which they have been held, and the finishing passes are taken at a lower temperature than present practice. Your committee understands that patents have been taken out covering this improved method of rolling, and that in the near future we may expect rails with more work on them, insuring a better wearing surface and a better wearing rail.

There is much diversity of opinion at the present time as to length of rails; we have advocates of 30-ft., 33-ft., 33-ft. 4 ins., 45-ft. and 60-ft. rails. The transportation difficulty has been the governing feature in fixing at 30 or 33 ft., the latter being considered the longest rail that can be handled conveniently in present length of cars. The advocates of 45-ft. rail think 45 ft. about the maximum length that can be used with reasonably close-joint spacing. Then we have the 60-ft. rail, taking out 50% of our joints. It is the experience of a part of the committee that 60-ft. rails can be laid with most excellent results on lines of easy grades and light curvature, with joints much closer than used in the average practice. It is believed that the best results will be obtained with 60-ft. rails when anti-creeping devices are used at least every 30 ft. The care of rail in laying and after laying, although of very great importance, is possibly second to some of the items mentioned.

R. W. Trimble, Pa.; S. M. Felton, C. & A.; A. W. Johnston, N. Y. C. & St. L.; Thomas Purcell, Mex. Nat.; C. A. Carpenter, L. S. & M. S.; C. E. Wickham, C. R. I. & P.; R. W. Hunt, Chicago; J. H. Wallace, Southern Pacific; G. B. Woodworth, C. M. & St. P.

The discussion turned largely on the poor wearing qualities of modern rails, due to the now universal practice of rolling rapidly and at a high temperature. Mr. P. Alex. Peterson (Can. Pac. Ry.), said that the old 60-lb. rail were better than the newer 80-lb. rails. He thought the association should adopt specifications and require the manufacturers to follow them, instead of allowing the latter to deliver rails made in the way they see fit. The physical treatment is really more important than the chemical composition. Capt. R. W. Hunt said that thousands of tons of rails are now rolled with the metal in the interior barely solidified. After making all the passes but one or two the rail should be held until it has lost part of its heat and then be given the final passes. The Tennessee Iron & Steel Co. is establishing a mill for making rails of basic steel, and if the Talbot continuous steel process is successful the Bessemer process may be relegated to the background. This Talbot process will reduce the phosphorus that the carbon may even be increased to 1%. Mr. Torrey (Mich. Cen. R. R.) referred to his use of continuous rails, in length of 250, 500 and 800 ft. Mr. Wallace (Ill. Cen. R. R.) said that, as to expansion, his road now gives a joint spacing for only half the theoretical expansion, thus reducing the wear on the rails at the joints. They find that the expansion can be controlled if the track is built in a sufficiently substantial way.

Uniform Rules and Organization.

There are many things to consider in undertaking to establish a uniform organization that can be applied to all railroads represented in this association; (1) Prejudice in favor of each road's present system; (2)

Economy of operation on some roads will compel them to do with a much less expensive organization than others; (3) The difficulty of adapting an organization to railways of unequal length and importance; (4) On some railways, part of the organization is provided for in the corporations by-laws, and it would be much trouble to change them.

I submit the following rough outline of a "Proper Organization of a Maintenance of Way Department," not with the authority of the committee, but merely to get the views of the association, to assist in getting our work started.

The Division Superintendent should be the general manager of his district, being in full charge of all departments. In maintenance of way matters, he should report to the engineer of maintenance of way or the chief engineer.

The Division Engineer should be the engineer of maintenance of way for his division, in charge of all maintenance of way work, and report to the division superintendent.

Each division should have at least one competent Assistant Engineer. He should be a man of practical experience, able to look after all work during absence of division engineer; superintend the erection of any structure; make surveys and do any work the division engineer or division superintendent may require.

of the records of all railway companies and what should be shown on them, and emphasize the importance of keeping them up to date.

It is very important that accounts and records of all transactions should be accurate, clear and arranged in a manner that admits of easy reference, for the records of the past furnish us the only reliable means of estimating the future. Why is it that the estimate of nearly every price of work falls short of the actual cost, if not because the cost of similar work in the past has not been accurately kept and properly classified? Anyone who has had experience in a maintenance of way office knows how hard

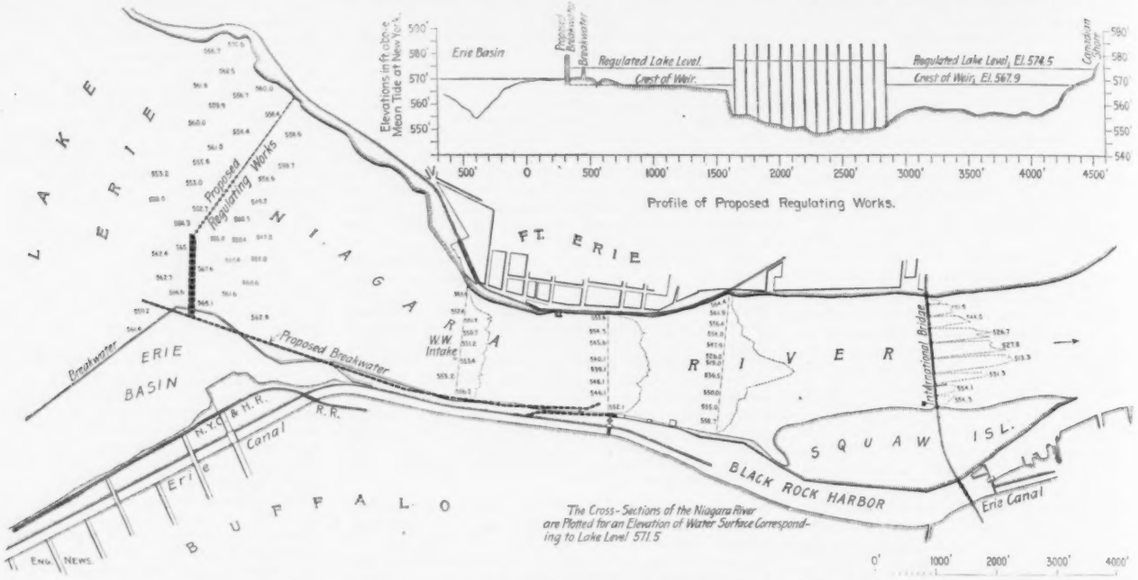


FIG. 1.—MAP AND CROSS-SECTION SHOWING LOCATION AND CHARACTER OF PROPOSED CONTROLLING WORKS IN THE NIAGARA RIVER FOR REGULATING THE LEVEL OF LAKE ERIE.

The Chief Engineer should be the active head of the department, and should be so fortified with assistants that he will have ample time to investigate all important subjects pertaining to the department; visit other railways in this, as well as in other countries, so that he can adopt for his company the very best methods practiced on the best railways in the world.

The Principal Assistant Chief Engineer will report to and represent the chief engineer, and attend to such duties as may be assigned to him.

The Bridge Engineer will report to the principal assistant or chief engineer. He should have charge of the designing of all bridges, trestles, culverts, etc. He should inspect all important structures as frequently as possible to see that they are properly maintained.

The Signal Engineer will report to the principal assistant or chief engineer, and will have charge of the designing and installing of all interlocking plants, automatic block signals, highway crossing alarm bells, and all other special signal work.

An Architect should have a place in the organization, and should report to the principal assistant or chief engineer. He will design and superintend the erection of all important buildings.

The Real Estate & Tax Agent will report to the principal assistant or chief engineer, and will have charge of all real estate and right of way of the company, and see that property is properly returned for taxation.

The Superintendent of Telegraph will have charge of the construction and maintenance of all telegraph and telephone lines, reporting to principal assistant or chief engineer, on all matters pertaining to said construction or maintenance.

The Engineer of Maintenance of Way is really the working head of the department, and will have charge of all classes of maintenance work, reporting to the chief engineer.

These seven can be considered the staff of the chief engineer, and this staff may be enlarged by such officers, as electrical engineer, etc., and all the above to be supplemented by assistant engineers, draftsmen, inspectors, clerks, etc., as circumstances may demand. Roads of short mileage or light traffic may dispense with part or all of the above officers, except the chief engineer, who may be able to perform all of the duties outlined above. The organization from this point, to the most subordinate position, can be applied the same for all railroads, whether large or small.

The Track Supervisor will report to the division engineer and should have charge of such a number of miles of road that he can give his personal supervision to all important work on the part of the road of which he has charge. Each part of the road so divided should be numbered and known as a district.

The Track or Section Foreman will report to the track supervisor, and the track of which he has charge will be numbered and known as a section. He should have charge of only so much of the road as he can keep in proper repair. This will be governed by the number of tracks and the traffic over them.

The Extra Gang Foreman will do such important work on the district as may be assigned him by the supervisor.

The Water Supply Foreman will report direct to the division engineer, and will have charge of all water stations within certain defined limits; keep up repairs; see that all stations are supplied with fuel and that the pumpers are on duty, and water is always ready for the locomotive when it arrives at the water crane.

There should be at least one gang of skilled carpenters with a competent foreman in charge on each division, to keep in proper repair all buildings. At least one bridge foreman with a gang of carpenters and laborers should be located on each division, to keep in repair all bridges and trestles. At least one foreman of masonry with a gang of masons and helpers should be located on each division, to keep in repair all masonry. These three will report to division engineer.

The division engineer should also have a Supervisor of Signals, who should look after the repairs of all signals on his division.

D. D. Carothers, B. & O. S. W.; W. J. Wilgus, N. Y. C. & H. R.; E. H. Futzhugh, Central Vermont; S. A. Quinlan, H. & T. C.; James Oborne, Can. Pac.; T. F. Whittlesey, T. & O. C.; C. S. Churchill, N. & W.; J. T. Mahl, Southern Pacific; F. B. Harriman, Illinois Central.

Records, Reports and Accounts.

The work of this committee should begin with the notes of the location survey, recommending the manner in which to keep these; then taking up the right of way deeds, with their numberless conditions and side agreements, all of which should be arranged for easy reference, and the original carefully preserved. It should recommend the scales for maps and profiles that form parts

it is to get an intelligent report from a section foreman or even from those from whom better things are expected, even when printed blanks are used. They are apt to get the right item on the wrong line or write it across several lines. The one thing that seems to claim their greatest effort is to give the total days worked correctly.

Material reports are generally less accurate than time reports. Now, unless the reports are accurate, what hope has the bookkeeper that he can present any figures that are worth anything? In view of these conditions, the committee should recommend few and simple reports of time and material.

H. F. White, B. C. R. & N.; Joseph Morrison, Cent. Vt.; L. F. Goodale, H. & St. J.; J. T. Frazier, B. & O.; D. McPherson, Can. Pac.; Henry Rohwer, Mo. Pac.; George Houliston, W. N. Y. & P.

PROPOSED PLANS FOR REGULATING WORKS FOR CONTROLLING THE LEVEL OF LAKE ERIE.

(With two-page plate.)

We illustrate in the accompanying cuts and on our double-page plate this week the general design proposed by the United States Board of Engineers

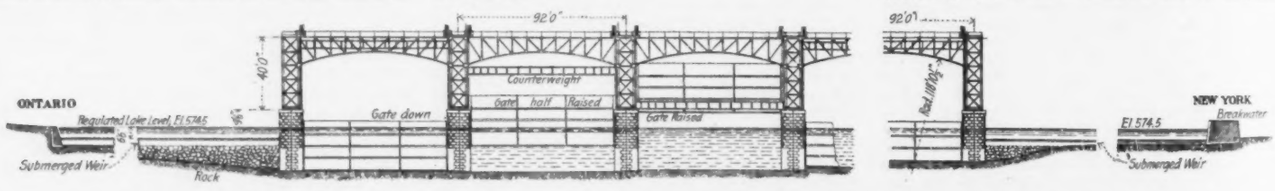


FIG. 2.—GENERAL ELEVATION, SHOWING RELATIVE ARRANGEMENT OF SLUICE GATES AND SUBMERGED WEIRS.

on Deep Waterways for the regulating works which it is proposed to build in the Niagara River, near Buffalo, N. Y., for the purpose of controlling the level of Lake Erie. The general proposition to regulate artificially the level of Lake Erie was quite fully discussed in our issue of Jan. 4, 1900. This discussion and the brief description of the regulating works which accompanied it, were based upon information contained in advance sheets of the report of the Deep Waterways Board which did not include the important diagrams and

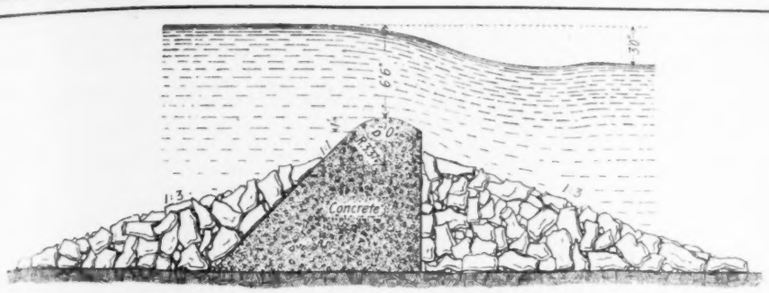


FIG. 3.—CROSS-SECTION OF SUBMERGED WEIR.

plans contained in the full report as it has now been printed. To supplement and complete the previous partial description we, therefore, publish the most important of these proposed plans here. While the problem of designing suitable regulating works partially to dam the Niagara River is simple compared with the other problems which will have to be solved before the actual regulation of Lake Erie can be carried out, the manner in which its solution has been proposed by the Deep Waterways Board will nevertheless be of interest to engineers.

Referring to the map and cross section, Fig. 1, which is reproduced from our issue of Jan. 4, 1900, it will be seen that starting at a point on the breakwater of Black Rock Harbor a rock reef, with an average depth of 6.6 ft. of water at the proposed regulated stage of Lake Erie, is utilized for a distance of 1,300 ft. to the bank of the main waterway of the river, as the foundation of a submerged weir. From the end of this weir the line of the works makes a deflecton of 35° and extends to the Canadian shore a distance of 2,810 ft., of which 170 ft. is to be sluice gate piers, 1,040 ft. sluice openings and 1,600 ft. submerged weir. The site has a rock bottom suitable for the foundation of the various structures for the entire length of the works. The rock reef from the Black Rock Harbor breakwater to the first sluice gate pier has approximately the elevation required for the fixed weir and will require but very little excavation to make it suitable for 1,200 ft. of the proposed length of this portion of the submerged weir.

Fig. 2 shows a general elevation of the proposed structure. The series of 13 sluice gates is flanked on each end by a submerged weir built of concrete protected by rip-rap, as shown by Fig. 3. It will be seen from Fig. 2 that the sluice gates work up and down between masonry piers surmounted by steel work towers, the tops of which are connected and braced together by cantilever trusses which support the runway from which the gates are manipulated. The towers are spaced 92 ft. apart, c. to c., and the sluices have a clear opening of 80 ft. each. Fig. 4 shows an enlarged plan and elevations of one of the sluice gates. As will be seen, the gate mechanism consists, first, of the gate leaf and its attachments and, second, of the operating machinery mounted on the pier towers.

The several elevations, plans and sections given in the drawings of Fig. 5 show the construction of the gate leaves proper quite clearly. Briefly described, each leaf consists of a steel famework covered with a steel plate skin. Suitable attachments on the top of the leaf at the outside ends are provided, to which the chains are attached with a pass over the operating sprocket wheel and carry a counterweight at their opposite ends. The construction of this counterweight is also shown by the drawings of Fig. 5. It will be noticed that this counterweight can be adjusted to any desired weight, and also that the gate leaf has a roller bearing on the guides. More complete details of this roller bearing are given by Fig. 6, which shows the arrangement of the operating mechanism on the pier towers. These drawings are so clear that they explain themselves. It is expected that two men will be required to operate each sluice gate.

The estimated cost of the portion of the work which has been described is $796,923, which sum is divided in the report of the Deep Waterway Board as follows:

Cribwork	$46,148
Piers	136,270
Sills	30,415
Gates	132,655
Counterweights	56,288
Chains	25,630
Superstructure	55,650
Hoisting gear	21,646
Roller trains	11,321
Submerged weir	140,900
Engineering and superintendence	75.00
Contingences	65.00

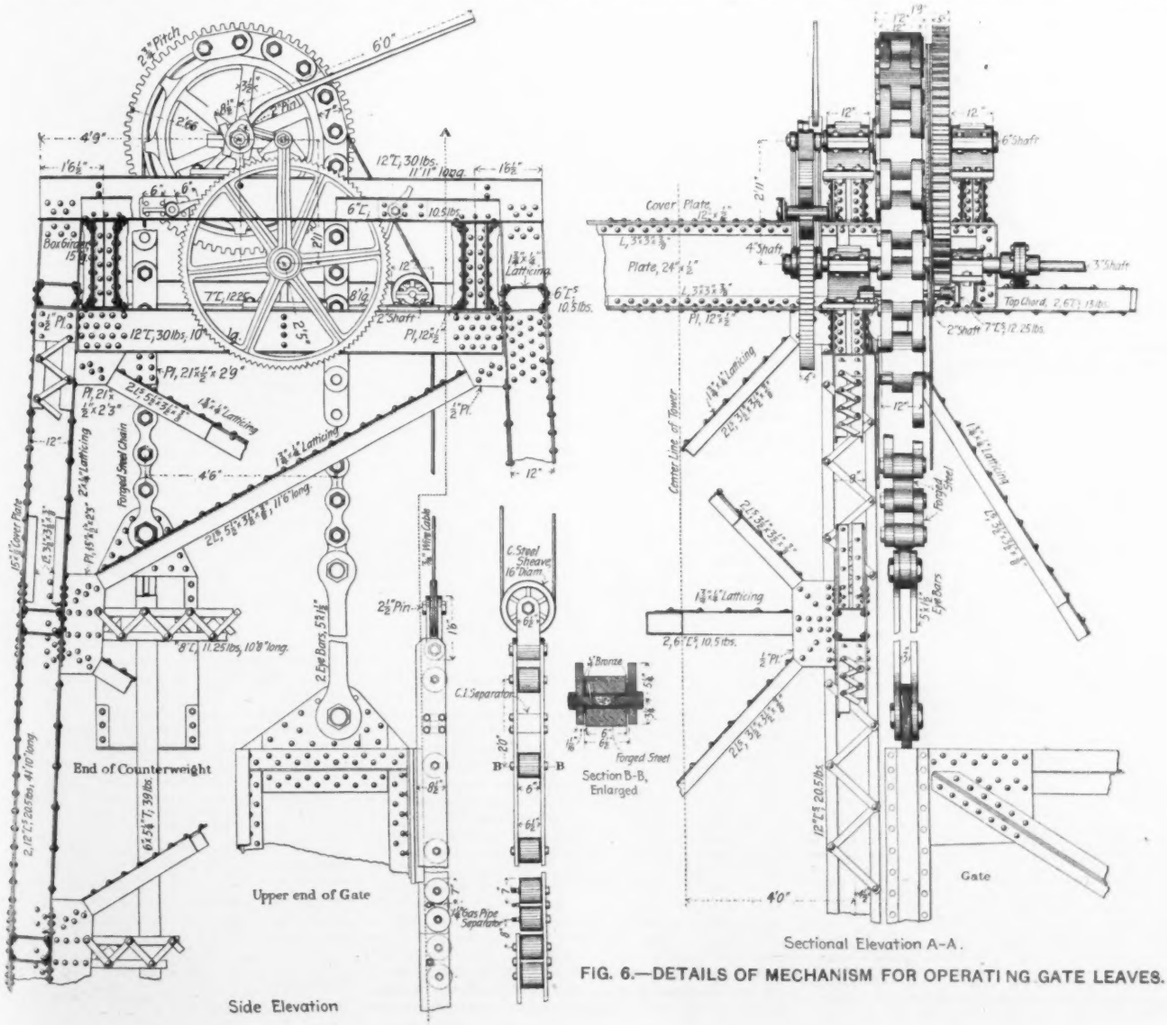


FIG. 6.—DETAILS OF MECHANISM FOR OPERATI NG GATE LEAVES.

Besides the regulating works proper the plan includes the construction of a lock at an estimated cost of $2,325,967, including the channel connecting it with the natural waterways at each end. It is pointed out in the Board's report, however, that such a lock will be a necessity with any project which provides for the same depth of channel for Tonawanda as for Lake Erie harbors and will very likely be required with whatever plan of improvement may be adopted for Lake Erie harbors and waterways.

ANNUAL MEETING OF THE AMERICAN RAILWAY ENGINEERING AND MAINTENANCE OF WAY ASSOCIATION.

The first annual meeting of this new association was held in Chicago, March 14 and 15, the meetings being held in Steinway Hall, and the headquarters being in the Victoria Hotel. The meeting was largely attended by representative men from all parts of the country, and was thoroughly successful in every way, promising well for the future of the association. Of the 14 standing committees, all but one presented reports, and that one made a statement, while the reports of eleven of the committees had been printed in advance of the meeting. Abstracts of several of these reports will be found in another column. It may be appropriate to state here that the management of the arrangements and the conduct of the proceedings were beyond criticism. The work did not lag and was not rushed, active interest was sustained throughout and every subject of the program was given its due share of attention. One notable feature was the constant attendance of practically all the members present, there being no flow of members in and out, which is such an unpleasant and discouraging feature of many technical conventions. This was due largely to the general interest displayed, and was aided by the practice of the presiding officer, Mr. J. F. Wallace, in calling up the committees at random, so that no member could tell when his committee, or a subject in which he was particularly interested, would be called up. There were no papers, although some of the committee reports were individual reports made by the chairmen, owing to lack of facilities for obtaining meetings of the committees, the membership of some of which is widely scattered. As each committee was called it took its place on the platform, and remained there during the reading and discussion of its report. The above remarks will doubtless interest many of our readers who are accustomed to the form of proceedings of other associations.

On Wednesday, March 14, the meeting was called to order about 10:30 a. m. The President, Mr. John F. Wallace, Pres. Am. Soc. C. E. (Asst. 2d Vice-President, Illinois Central R. R.), was in the chair, and several of the Vice-Presidents occupied seats on the platform. The first proceeding was the reading of the annual address by the President, and an abstract of this is given below:

At this, the first annual meeting, it would seem proper to state in a general way the problem that is before us for solution, to give an outline of progress to date, and to suggest the general lines upon which our future work should be carried out. In October, 1897, a circular letter was addressed to railway officials in the United States inviting an expression of opinion on the subject of the organization of an association of railway officials interested in or connected with the engineering and maintenance of way departments of American railways. Over 100 favorable replies were received, and on Oct. 21, 1898, a preliminary meeting was held at the Auditorium Hotel in Chicago, about 20 railway officials being present. Mr. A. Torrey, Chief Engineer of the Michigan Central R. R., was chosen Chairman, and Mr. L. C. Fritch, Division Superintendent of the B. & O. S. W. R. R., was chosen Secretary. At the meeting held in Buffalo, March 20, 1899, a draft of a constitution was adopted, and permanent officers were elected. During the past year the officers and Board of Directors have held numerous meetings, selected the various committees, and revised and perfected the outline of committee work.

The present railway mileage in the United States, Canada and Mexico is approximately 216,714 miles, owned by 2,200 different corporations. Many of these lines, however, while having a distinct legal existence, are either owned, controlled or operated by other corporations. The number of accounting corporations is approximately 1,100, and the number of actual independent operating corporations 850. The railway properties are capitalized at approximately $10,000,000,000, 54% of which is represented by stock (common and preferred) and 46% by bonds. Of the common stock 66% does not receive dividends, and 16% of the bonds pay no interest. The average rate of dividend on those roads paying any return on their stock is 5.3%; that is, 34% of the railway stock of the United States, Canada and Mexico pays annually 5.3% on the investment. The valuation of all railroad properties on a 5% dividend basis would be in round numbers $7,000,000,000. The amount expended on maintenance and structures of all these roads during the fiscal year ending June 30, 1898, was estimated at $188,000,000. Owing to the more prosperous times these expenditures have been rapidly increasing, until at the present time they are placed at $200,000,000 annually. It is also estimated that $180,000,000 per annum is being expended in improvements and extensions, provided for out of increased capitalization and not charged to maintenance; this sum covering the construction of new lines, reduction of grades on existing lines, additional tracks, terminal facilities and general improvements to the properties. Approximately 20% of the total expense of operation of all the railways is due to maintenance of way and structures. According to the last official reports there were 288,000 employees in the engineering and maintenance of way departments, at a total compensation of about $100,000,000 per annum. At the present time this number is no doubt much larger.

It is desired to bring into our association not only civil, mechanical and electrical engineers, whose general professional training may fit them for working out the solution of the technical part of the problem, but also all classes of railway officials having supervision of maintenance of way matters, from general managers down to engineers of maintenance of way in charge of divisions, or other railway men bearing other titles but performing similar duties. The term general manager is used in its larger sense, and is intended to embrace presidents, vice-presidents, or other officials interested in the general management of railway properties. Our membership is intended to include two elements, the technical and the practical, and it is hoped and expected that the intercourse between the technical engineer and the practical railway man will be of mutual benefit. The work of our association has been laid out on unique lines. It is the intention to cover the entire field of engineering and maintenance of way research, divide up the subjects in systematic order, and continue and increase our standing committees and the subjects under consideration from time to time in order to do so. It was not the intention, nor is it possible, for any of these committees to exhaust the subject matter given them for consideration in a single year, or even within the lifetime of the individual members. The first work of each committee should be the collection of facts, which should be properly compiled, condensed and abstracted for the information of the association at large. As the full facts are obtained under the different heads or sub-heads, reports can be made from time to time by the different committees.

We should not forget that we are the servants of the investers in railway securities, and that it is our duty to endeavor to secure the largest possible return on the capital invested. It is the function of the railway to furnish transportation to the public with the maximum amount of speed and safety to person and property, the greatest convenience to its patrons and at minimum cost. We should have it in mind that the highest economy in the location, construction, maintenance and operation can only be obtained when the interest on cost of construction plus the expense of maintenance and operation are kept down to the minimum. It is not economy to so locate and construct a line of railway that while the expense of operation and maintenance will be very low, the saving will be more than counterbalanced by the excessive fixed charges due to the large original outlay. On the other hand, it is not economy to locate and construct your road so cheaply that while the fixed charges may be comparatively light the cost of operation and maintenance will be excessive. This principle applies not only to original location and construction of a railway, but to all the improvements and additions which may seem necessary or desirable after the line has been placed in operation. For instance, it may be economy on some roads to make large expenditures in the reduction of grades, if this expenditure will result in a saving on operating expenses in excess of the fixed charges due to the investment. It is economy to construct water tanks of large capacity, if by so doing the service of night pumpers can be done away with and a sufficient amount saved on operating expenses to justify the outlay. It is economy to provide passing tracks if such are necessary in order to facilitate train movements, thereby reducing the length of time consumed by trains on the road or rendering the train service more efficient. It is also economy to make numerous expenditures upon which no actual saving in operating expenses can be shown, provided these expenditures will develop new business or prevent existing business from going to rival lines, to such an extent as will justify the outlay. But the ultimate result of all railway expenditures is, and should be, net profit to the investor.

This was followed by a brief report by the Secretary, Mr. L. C. Fritch (B. & O. S. W. R. R.).

The report of the Committee on "Yards and Terminals" was then presented by the Chairman, Mr. A. W. Sullivan (Gen. Supt., Ill. Cent. R. R.), and an abstract is given elsewhere. The report was brief and referred to the important relations which yards and terminals bear to the efficient and economical operation of the traffic. The discussion was mainly in the form of suggestions of matters of detail to be considered by the committee, including the interlocking of switches at the entrance to yards, the elimination of facing switches at these points, and the provision of accommodation for trainmen during the time that they lay over. Gravity yards were also referred to, and it was suggested that the lead track should be long enough to take the largest possible train, crossovers being introduced for the accommodation of shorter trains.

The report of the Committee on "Grading" was then presented by Mr. W. McNab (Asst. Engr., Grand Trunk Ry.), and an abstract of this will be found elsewhere. The report of the Committee on "Buildings" was presented by Mr. W. H. Parkhurst (Engr. of B. & B., Ill Cent. R. R.), but merely outlined the way in which it is proposed to organize the committee for its work. The report of the Committee on "Masonry," presented by Mr. W. L. Breckenridge (Chf. Engr., C. B. & Q. R. R.), was of a similar character, but implied that particular attention will be paid to culverts and to the use of concrete. In the discussion the question was put, "Is concrete masonry?" and it was stated that in a certain case an agreement provided that a bridge should have "masonry" piers. When it was proposed to use concrete, objection was made that this was not masonry, masons not being employed in its construction. Mr. P. Alex. Peterson (Chf. Engr., Can. Pac. Ry.) said that on his road Italian laborers are employed on masonry, and that they (working according to their own ideas) use but half the amount of cement used by ordinary masons. He has also used concrete with large stones embedded therein. The use of segmental instead of circular arches was also suggested, as giving greater waterway under less head. The report of the Committee on "Water Service" was then read by Mr. W. E. Dauchy, (Chf. Engr., C., R. I. & P. Ry.), and an abstract of this is given elsewhere. In the discussion, Mr. John F. Wallace (President) stated that on the Illinois Central R. R. the water service is under the Chief Engineer, who has general charge of all maintenance of way matters, and he has a special staff to investigate water supply matters for the whole system.

The meeting closed at 2 p. m., and at 2:30 p. m. the party started on a special train to see the Drainage Canal. The train was tendered by the Atchison, Topeka & Santa Fe Ry., and the run was continued to Joliet, where the party visited the McKenna rail re-rolling mills. Old 56-lb. rails were being heated, rolled, sawed and delivered as 73-lb. rails. Before going to the furnace the burr on the gage side of the railhead is ground off.

On Thursday, March 15, the meeting was called to order about 10:30 a. m., when the report of the Committee on "Signaling and Interlocking Plants" was presented by Mr. H. D. Miles (Sig. Engr., Mich. Cent. R. R.). This consisted mainly of a classification of the subjects to be considered, some additions to which were suggested in the discussion. The report of the Committee on "Ties" was then read by Mr. G. W. Kittredge (Chf. Engr., C., C., C. & St. L. Ry.), and an abstract of the report and discussion will be found in another column. The next report taken up was that of the Committee on "Ballasting," which was presented by Mr. W. H. Peddle (Gen. Supt. of Maint., So. Ry.), and an abstract of this also is given in another column. The meeting then adjourned from 1 to 2 p. m.

At the afternoon session, the first committee called was that on "Rails," whose report was read by Capt. R. W. Hunt. An abstract of this is given elsewhere. The Committee on "Uniform Rules and Organization" was then called, and a report was read by Mr. D. D. Carothers (Engr. of M. of W., B. & O. S. W. R.). This created some amusement from the fact that the report was vigorously criticised and objected to by other members of the committee, as there had been no opportunity for a committee meeting, and the report was practically a paper by Mr. Carothers. One point on which the committee failed to harmonize appeared to be the recommendation of the "division" system, under which the division engineer is practically general manager of his division (Eng. News, Oct. 19, 1899). The proposed system of organization is described elsewhere.

The Committee on "Track" presented a short report dealing with some of the subjects to be considered. This was presented by Mr. H. C. Landon (Buf. & S. Ry.). In the discussion, Mr. Thomas Appleton (Chf. Engr., Copp. R. R. R.) brought up the question of the relative economy of light rails with many ties or heavy rails on fewer ties. Mr. Wallace (President), however, pointed out that increased weight of rail is no reason for reducing the number of ties. The deflection of the track as a whole depends very largely upon the spacing of ties, and will be less with the greater number of ties. Mr. Sullivan (Gen. Supt., Ill. Cent. R. R.) suggested that there should be a definite relation of weight and speed of trains to construction of track, in order to get the most economical relations, but it was shown that traffic conditions are such that it would be almost impossible to establish any close relation between a certain weight or speed of train and the character of track upon which it could be safely and economically operated.

The Committee on "Bridges and Trestles" had no report to make, but Mr. W. A. McGonagle (Chf. Engr., Dul. & I. R. R. R.) made a statement of the proposed scope of the committee's investigations, and suggested the establishment of a fund, to which the railways should be asked to contribute, to carry out experiments in regard to the actual strength of bridges and bridge members. One member stated that engineers are continually being confronted with the question whether a certain bridge can safely carry a certain load, and, if not, whether the bridge should be strengthened or trestled, or replaced by a new structure. The report of the Committee on "Records, Accounts and Reports" was then presented by Mr. H. F. White (Chf. Engr., B., C. R. &. N. Ry.), and is given in abstract in another column. The committee on "Signs, Fences, Crossings and Cattleguards" had no report, but Mr. C. A. Wilson (Chf. Engr., C., H. & D. R. R.) outlined the committee's plans. In the discussion it was shown that legal obligations as to these four subjects exist in certain states, and must be taken into consideration. Also, that a cattleguard which is quite successful in one part of the country may be a failure in other parts. In fact, one member stated that the only safe plan on certain roads is to issue a time card to all cattle and hogs along the line.

This ended the technical part of the proceedings, and the Secretary then announced the result of the election of officers as follows: President, John F. Wallace, Asst. Second Vice-President Illinois Central R. R.; First Vice-President, P. Alex. Peterson, Chf. Engr. Canadian Pacific Ry.; Second Vice-President, W. G. Curtis, Engr. of M. of Way Southern Pacific Ry.; Secretary, L. C. Fritch, Supt. B. & O. S. W. R. R.; Treasurer, W. S. Dawley, Chf. Engr. C. & E. Ill. R. R.; Directors, W. K. McFarlin (Chf. Engr. D., L. & W. R. R.), Hunter McDonald (Chf. Engr. N., C. & St. L. Ry.), Don J. Whittemore (Ch. Engr. C., M. & St. P. Ry.), F. H. McGuigan (Gen. Supt. Grand Trunk Ry.), A. Torrey (Chf. Engr. Mich. Cent. R. R.), Thomas Rodd (Chf. Engr. Penn Lines). This was a re-election of the officers of the past year. After a vote of thanks to the President and Secretary for their work on behalf of the association, the meeting adjourned. In the evening a banquet was held at the Victoria Hotel.